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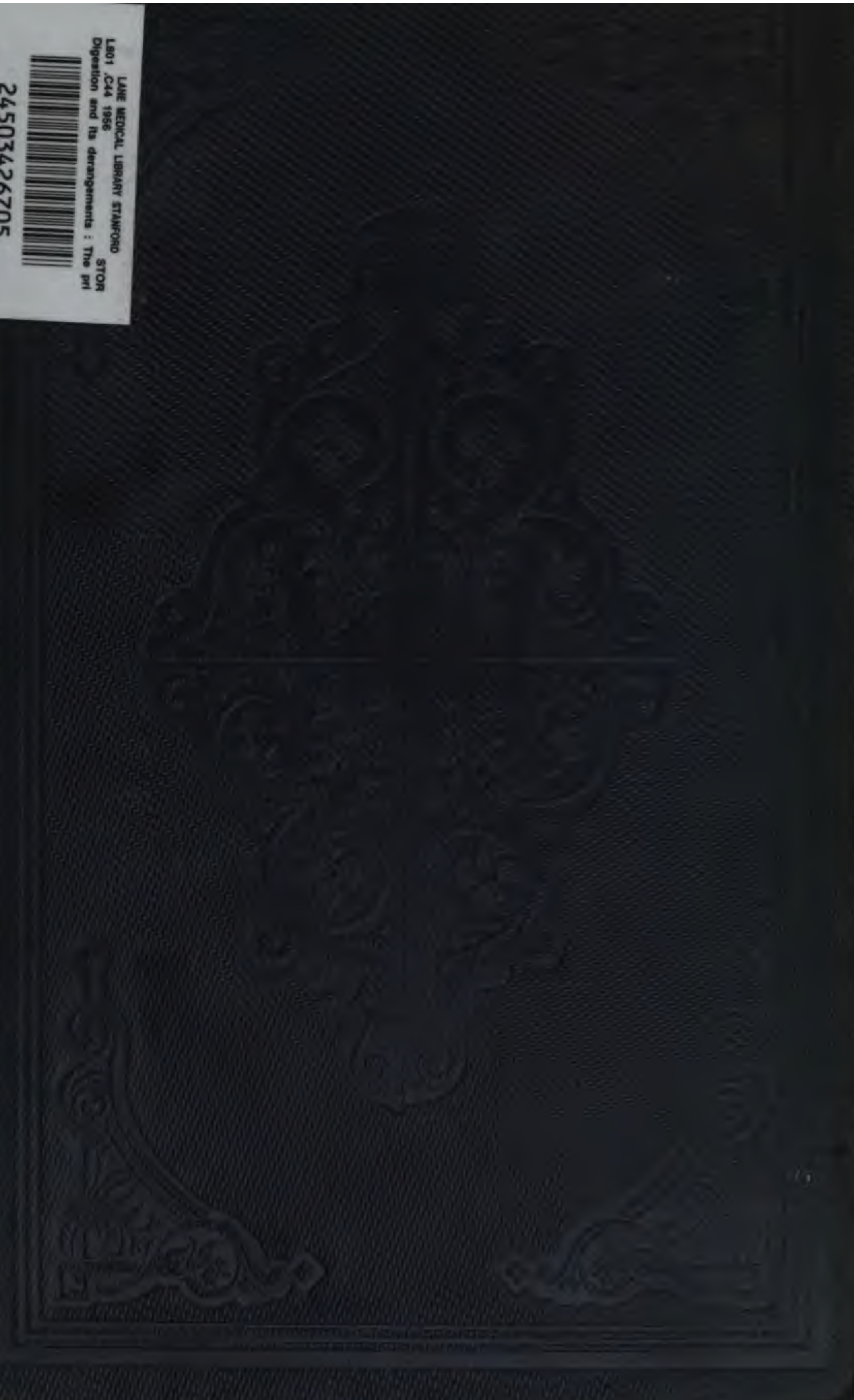

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DIGESTION

AND ITS DERANGEMENTS.

THE PRINCIPLES OF RATIONAL MEDICINE APPLIED TO DISORDERS OF THE ALIMENTARY CANAL.

BY

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PREFACE.

THE publication of this volume has been delayed beyond its intended time, by the addition to my ordinary professional engagements of work connected with the expansion of the school at St. Mary's. Some scientific observations are therefore occasionally spoken of as in progress, or recent, to which the past tense should more properly be applied. But yet I am not aware of any alterations of fact arising from this circumstance, otherwise I should have felt it my duty to take notice of them in a note, or to have reprinted the sheet.

No profession of original research is made in the first, or physiological, part of the volume. It is simply an attempt to join the *disjecta membra* of recent observations on the subject of digestion into a connected sketch—to offer a concise picture of these vital processes, such as may be present to the mind of a practitioner, who is continuously employed in modifying them for the relief of pain and preservation of life, without overloading his scanty leisure by prolonged quotation. In the second part it was of course the author's duty to draw from the life only.

THOS. K. CHAMBERS.

1 *Hill Street, Berkeley Square,*
Nov. 1, 1855.

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BOOK I.

DIGESTION

AND ITS DERANGEMENTS.

CHAPTER I.

INTRODUCTION.

There is no pedantry in definitions when they truly lead the writer and reader better to understand one another. Let it therefore be said at starting, that in the following pages "Digestion" will mean *that process by which supplies are taken into the blood from the alimentary canal.* The essence of the process consists in *absorption* from a canal communicating with the external air into a closed system of tubes where is contained the nutritive fluid. Preparatory to this absorption is *solution*, aided by *muscular and nervous action*, and the end of it is *assimilation*, or the conversion of the substances received into a like nature with the fluid they float in. Till this has been done, they cannot be used for the nourishment of the body.

The blood is the floating capital lying between absorption and nutrition—a treasury liable to continuous drafts from the latter, and requiring therefore constant supplies from the former to keep up its efficiency.

In the vegetable world truly it is difficult to point out where one act ends and the other begins. The nutriment of the plant dissolved in water is received by the terminal cell at the tip of the root, and handed on from closed cell to closed cell, passing through their membranous walls, till, as it approaches the goal of its journey, it supplies substance to the imperfect and new cells which it helps to form in fruit, flower, or leaf. Here the first producer or receiver of the article is of the same nature as the consumer. But in animals, the higher we ascend in the scale of creation, the more strongly marked and easy to recognise is the distinction between the receiving and the using the means of growth,—the more special is the apparatus assigned to making and moving the blood,—the more obviously distinct is its devotion to what may be called "the carrying trade" of the bodily economy.

By this broad line of demarcation we are enabled to point to a separate series of organs appropriated to the offices of digestion, all of which are, physiologically speaking, *anterior* to the blood. Of these offices it is attempted in the following pages to offer such a picture as may be present in the mind of a practitioner in medicine during his daily task of modifying, mainly through their influence, the phenomena of life,—such as may assist him, as far as the actual state of knowledge will allow, in having a rational basis for empirical treatment, a picture, rugged indeed and imperfect in its outline, but capable of being filled up by observations derived from his own experience or contributed by the special researches of those purely devoted to a philosophical life.

The author believes that in no way is both the science and the art of healing so likely to be improved, as by the association in its literature, and through that in the minds of its practitioners, of pathology with physiology rather than with morbid anatomy;—that juster theoretical views are elicited by looking upon disease as part of the phenomena of life than as the producer of appearances seen after death;—and that patients are more likely to be cured by one, whether original observer or reader, who is considering even imperfectly the vital actions exhibited by them, than if he knew exactly what would be the consequences of the disease in the corpse.

In no department of medicine is this association so important as in that which relates to derangements of the digestive organs. Morbid anatomy here gives us less help than in any other classes of disease; the changes of those viscera found in the dead body have less relation to the phenomena during life than in other cases; and if the science is forcibly driven to answer questions for which it is not calculated, it will give erroneous information. For why?—the changes seen by the morbid anatomist are those of solids exhibiting faulty *nutrition*, a process essentially posterior to the blood—whereas the process whose derangements we have to consider in this volume are essentially *anterior* to the blood. Besides which, even when the derangement does depend on a faulty nutrition of a digestive organ, its constituent and most important parts are so delicate, that the rough process of death generally destroys all their peculiarities.

In this First Book, "On Digestion," a sketch will first be given of the several parts concerned in that function which are common to the whole alimentary tube; then the several portions will be examined connected with the several peculiar solvents which they possess; and then the substances which these parts are designed to receive.

A similar plan will be followed in the Second Book, "On the Derangements of Digestion," so that the several chapters may be, as it were, complementary to each other, the organ being exhibited in the first book in its typical state; in the second, in its deviations; both being in fact equally manifestations of physiological laws.

Authorities in the hands of everybody, especially English ones, will be alluded to rather than quoted; but where from various causes they are not so generally accessible, they will be cited in greater detail. The recent labours of Professors Bidder, Schmidt, Kölliker, Lehmann, and other physiologists of German race, have added so much to our knowledge of the animal frame by their great and well-directed industry, and are at present so little known in an English dress, that apology is scarcely necessary for the frequent recurrence of their names in the First Book. When the English government affords equal facilities for the devotion of some of its subjects to a philosophical life, as the German and Russian, then the authorities in physiological works will have a more home nomenclature. At present, let us be content to thank our neighbours for fruits not of native growth.

Details unnecessarily to the purpose, or which, in other words, have no practical bearing at present discernible on our art, will be omitted. And some parts of the physiological argument, not absolutely required to carry on the thread, will be put into smaller type, principally for the sake of economy in space.

CHAPTER II.

PARTS OF THE ORGANISM CONCERNED IN DIGESTION WHICH ARE COMMON TO THE WHOLE ALIMENTARY CANAL.

THE chief instrument for taking up into the system substances introduced by the mouth, is obviously the mucous membrane, which extends in a tubular form through the trunk. It is this we have to consider, both in its common properties as one great organ, and in the differences which the several parts of it exhibit; for it is with this surface alone that the substances to be absorbed come into contact.

Let us first think on the external surface of the mucous membrane as a whole. And let us think on it in the state in which we can see it by looking into our mouth and throat. Its aspect there is somewhat different, certainly, from what it is in the remote parts of the alimentary canal, but not so different, or nearly so different, as living and dead tissue. The intestines as the anatomist sees them, are about as much like the intestines in health, as the crumpled folds of dank parchment which surround the mouth of the corpse resemble the same lips swelling with warm life and expression. One impression drawn from the life is worth ten from the museum. Let the picture then which is painted on our minds, present the whole of the digestive track, with its chief features taken from the familiar view of the fauces in a looking-glass.

SECTION A.—*The Epithelium.*

At the lips the tough opaque Epidermis becomes the delicate translucent Epithelium,[*] lying on, but scarce concealing, the

---

[*] It is a pity, when we consider its likeness to *Epidermis*, that the word, as first devised by Ruysch, "*Epithelis*" (*Thesaurus Anatomicus III.*, No. xxiii., not. 2), should have fallen into disuse. He himself afterwards calls it "Epithelia" (*Thes. Anat. VII.*, No. xl.), and the course of a century and a half has neuteralized the substantive.

θηλαὶ or papillæ. It is formed, like all tegumentary tissues, of minute scales or cells, packed in layers like figs in a box. These are easily seen, by scraping the surface of the fauces and putting the saliva under a lens, to retain still their identity as separate bodies, having clear defined outlines, and each one its own nucleus. They are not massed into an homogeneous substance, like more advanced textures, but retain their nascent condition of distinct individuals, with a certain interval between each, in a much greater degree even than in the epidermis of the outer body. Hence the looseness of structure, dilatability without elasticity, and the characterizing of the whole web by the transparency which individual cells possess.

A further impression of this free looseness or openness of texture is produced when we find that in chemical constitution, as well as in the form of its ultimate particles, epithelium and epidermis are identical. It is the position or packing of the particles in which they differ.

Dr. Janus Tilanus, of Arnheim, has watched under a microscope the effect of various chemical reagents on the epithelial and epidermic scales, and arrived at the conclusion, that there is no difference between them. In *concentrated caustic potass*, both shrink and sometimes shrivel; on the addition of *water* to the said shrunken scales, they swell up again in five minutes; and after two days' immersion in the *potass thus diluted*, they become globular or oval, in which condition they will remain after a fortnight. In *concentrated acetic acid* they swell; in *dilute acetic acid* they swell quicker, and in six hours become quite biconvex, and exhibit their nuclei more distinctly. *Ferrocyanuret of potassium* does not affect them. Digestion for twenty-four hours in *concentrated nitric acid* does not destroy the scales, but stains them yellow; which colour is not removed by neutralizing the acid with ammonia. After eight days they become wrinkled, but still acquire the elliptical form on the addition of ammonia or potass. Hence he concludes "nullam differentiam chemicam inter cellulas epidermidis et epithelii ex ore inveniri."*

We thus get an idea of a surface composed of numberless similar bodies: in the first place, *separate individuals*, and therefore with intervals between them; secondly, *not easily destroyed by chemical or* (from their minuteness) *by mechanical agents*, and therefore peculiarly permanent; thirdly, much *modified temporarily* in their shape by these agents, especially by the most common of them—water; admitting the substances in different degrees quickly and freely, parting with them when subjected to various processes with equal facility.

---

* *Tilanus de Salivâ et Muco*, pp. 44—56. Amstelodami. 1849.

It is easy to imagine such a surface peculiarly adapted to the passage of liquids in both directions, inwards and outwards; and at the same time so altered in its physical characters, by differences in the qualities of the liquids, as to transmit them quickly, slowly, separately, mixed, pure, or self-modified in chemical constitution during their passage, in almost infinite variety. Each separate particle is variously permeable, and the intervals between them variously permeable too. The differences depend on the substances themselves, as far as we see, and not on the membrane. Certainly such an organ may exercise an apparent selecting power over what it takes up and what it rejects, without the intervention of any psychical forces.

SECTION B.—*The Bloodvessels.*

Let us continue our reflections by turning down the under lip before a mirror, and observing the infinite multitude of capillary bloodvessels ramifying immediately beneath the transparent scarf skin. There is evidently, from the colour, as much blood as vessel. As blood, from the quantity of solid matter visible in it, has a right to be called a semi-solid, this membrane has an equal right to be thought of as a semi-fluid. And when we think of it as semi-fluid, let not the idea of a stagnant marsh be presented to us, but of a headlong rapid. It is a useful way of keeping alive our feelings about the circulation, to examine through the microscope occasionally the toe-web of the slow-blooded frog. The action and ceaseless whirl of the living stream we see there quite drives us dizzy. What then must it be in our own warm selves! If in a membrane so little animated as the frog's toe or the bat's wing, which by the naked eye we should judge to be entirely devoid of blood, we still see such a net-work of tubes conveying it—if, in a creature, the greater part of whose blood is driven from the extremities to the centre by the temporary fright we cause in putting him under a microscope, we find such a busy scene of circulation—

what must be going on in a tissue glowing with red life and health!

Now the perfection and rapidity of the circulation has a good deal to do with the absorbing power of mucous membrane. And, moreover, the life of those membranes is not a necessary co-efficient in this influence; for the phenomena of endosmosis explain much of it, and those phenomena can be exhibited in substances devoid of life.

It is quite true, as is said by Mr. Dutrochet, the re-discoverer* of these phenomena, that the word he invented imperfectly expresses his meaning. There is something different from an *ἐνδον ὠσμος*—a pushing inwards—going on in the membranes where they are exhibited.

Now the chief facts observed with regard to membranes and their connexion with liquids, are the following:

1. If a moist membrane be interposed between two watery solutions of different densities, two currents will run through the membrane, one from the denser to the rarer liquid, and one from the rarer to the denser, and the latter will be the strongest *cœteris paribus* in proportion to the density.

2. The current is much increased in the direction of a liquid set in motion.

3. The current is increased in the direction from an acid to an alkaline fluid.

4. The activity of endosmosis increases with the temperature.

5. It is different through different membranes.

An old experiment easily tried well illustrates the first law. If a bag-shaped membrane, say the cæcum of a fowl, be suspended in a jar of water, and partially filled with a solution of gum or salt, or any other dense fluid, up to the level of the water outside, it will be found that in a few hours the interior level has considerably risen, from the in-draught through the membrane. Exactly the opposite results will take place, that is, the level will have sunk, if the proportionate densities of the fluids be reversed.

The increase of the current in the direction of a moving liquid is shown by a beautiful experiment devised by Kürschner. A piece of small intestine is cleansed, and laid in a vessel filled with a solution of sulphocyanide of potassium. A funnel is then attached to one end of the gut, and a moderately dilute solution of chloride of iron passed in a continuous stream through it. Now, if the two solutions are both in a quiescent state, more of the sulphocyanide will enter into the chloride than of the latter into the former, as will be shown by the relative intensity of red colour in the fluid inside the intestine. But the establishment of even a moderate stream greatly intensifies the circumstances; the solution in the open vessel is much less coloured than before; and when the current runs quickly, there is scarce any colouring of the sulphocyanide at all.

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* W. Fischer, in 1814, first noticed the phenomena, but the want of a name seems to have caused them to be passed over, and Mr. Dutrochet was unacquainted, in 1826, with his experiments.—*Jolly* in Henle's *Zeitschrift*, 1849, p. 83.

The aid afforded to endosmosis by the acidity and alkalinity of the two liquids, was inferred first from the observations made by Professor Graham on "Diffusion." He noticed, with great wisdom, that we were experimenting on the conduct of two liquids with a membrane between them, before we were acquainted with their conduct *without* a membrane between them, and turned his attention therefore to this point. It is not known yet how far the laws of this simple diffusion of liquids into one another resemble those of endosmosis. In some respects they certainly differ, and, of course, must modify much one another. In the experiments on endosmosis, we do not know yet what part is pure diffusion and what is endosmotic diffusion.

When, therefore, we notice the following law, there is the same doubt thrown upon it as to whether it is a law of diffusion or endosmosis as there is on the two former.

Professor Graham found the power possessed by acids of diffusing themselves through a liquid with which they are in contact very great, and that of alkalies very small. Thus, for example, hydrochloric acid belongs to the class of most diffusive substances known; it appears to exceed hydrate of potash at 53·5° as 7·56 is to 6·12 or as 100 to 80·9. He found also that acidified albumen diffused itself in much greater proportion than when alkaline. Hence he infers the law above given to hold good in diffusion.

Mr. Dutrochet, in his former experiments, showed that the same rule is valid in respect of endosmosis through interposed membranes.

There are, besides, several other circumstances which hasten or retard endosmosis apparently in both directions. One of these is *temperature*. Dutrochet observed that heat increased the rapidity of the action. Mr. Jolly, in some recent experiments, has confirmed this, and added, moreover, that it is not increased in an even ratio, but that in lower temperatures the ratio of increase is greater than in the higher. Another is the *nature of the membrane*. There seems to be a considerable difference between membranes as to their relation to different fluids. For example, if alcohol and water be separated by an animal membrane, the strongest stream passes from the water to the alcohol; if by a piece of caoutchouc, in the contrary direction. Through a pig's bladder the water passes much quicker than through an ox bladder. But the law of these differences has not yet been investigated.*

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* *Kürschner* in Wagner's *Wörterbuch*, quoted in Lehmann's *Phys. Chemie*, iii., 267: *Dutrochet*, "Endosmosis," in *Cyclopædia of Anatomy*: *Graham*, Bakerian Lecture, *Philosophical Transactions*: *Jolly*, Henle's *Zeitschrift*, p. 82. 1849.

There are, then, in the circumstances under which the blood-vessels and the contents of the bowels are placed, three very marked principal things which promote the passage of fluids into the former from the latter in a greater degree than the reverse. These are:

1. The comparative density of the blood.
2. Its rapid motion.
3. Its alkalinity.

While at the same time the animal warmth keeps up the general activity of the endosmosis in both directions, and probably certain uninvestigated peculiarities of the membrane lend their aid.

That other physical conditions also assist is highly probable. We are yet only on the threshold of the inquiry, having but lately acquired a competent knowledge of the various structure of these membranes, and not having brought that knowledge to bear, as it must eventually do, on the laws of endosmosis. Then again, these laws have been studied only in the gross, as they are exhibited in membranes generally, and not in particular sorts of membranes. No mode has been as yet devised for estimating the influence of those parts—the epithelium, for instance—which exist in an efficient form only during life, and after death are separated from their connexions or destroyed. Yet must their influence be very great. Indeed, microscopic observation of the parts, where death had occurred during digestion, would have, *if taken by itself*, led to the conjecture that it was here that the *chief* influence lay. I refer to the accounts given of the passage of fat through the membrane, in which process the epithelium undergoes such marked changes.

But taking into account only these three efficient laws of absorption, we shall on a review of them, gain a clearness of ideas respecting its phenomena, and learn to attach such a comparative value to many of the sources of its disturbance, as cannot well fail to be useful.

For this end let us review the variety of ways in which the actions contemplated may be disarranged.

In the first place, the *density* of the blood is continually diminished by that very act of endomosis which it promotes: the entrance of water into it makes the fluid thinner every moment.

There is provided therefore as a counterpoise a constant drain of water out of the body by evaporation and by urine. It is parted with in brimming streams by the skin and by the lungs, as touching or breathing on a cold surface perpetually reminds us. But the even march of this evaporation is constantly interfered with. The saturation and temperature of the air vary from minute to minute; and were they to remain equable, the necessities and the wilfulnesses of the animal world change them nearly as often as their own nature now does. A man lives, and makes his horse and his dog live, in all possible degrees of warmth, cold, dryness, and moisture; sometimes cabined in one constrained posture hour after hour in an atmosphere saturated with exhalations from his body, sometimes in violent motion under the pure sky; while at the same time he scarcely at all alters the amount of fluid taken in, but drinks by the gallon or the spoonful, according to his fancy. Evidently the outlet for water provided by the urinary apparatus is a great perfection in the higher animals: it enables them without much inconvenience to be as careless about their evaporation as their pleasures and business require. Birds have not this outlet, for their semi-solid urine takes away no water worth speaking of. But to compensate for it they have an enormous evaporation by the lungs from their rapid breathing, and changes in the temperature of their external surface are carefully guarded against by clothing which is the slowest conductor of heat in the known world. However, with both these precautions, they are much less able to bear varying climates than mammalia; and many of them spend a considerable part of their lives in an exhausting pursuit after the summer.

Man then being amply furnished with evaporating surfaces, and their assistant or deputy, the kidneys, is thus enabled to keep his blood in a sufficiently thick state for absorption, under ordinary circumstances. But to what severe trials he puts these provisions for safety!—changing the temperature of the body from one extreme to another, and forcing the kidneys suddenly to take the whole duty, and then perhaps doubling that duty by copious libations—running "from Indus to the Pole" in pursuit of his various objects, and pertinaciously refusing to vary his diet with his clime.

There is considerable difference in the density, arising from the solution of salts, &c., in the blood of different parts. Dr. F. Schmidt found the blood of the vena portæ always of less specific gravity than that of the jugular vein. This difference varied a good deal according to circumstances. It was most marked after copious draughts of water. After a full meal of nourishing diet, however, the difference was very slight. His experiments are a good illustration of the constant variation which must take place both in the absolute density of the whole circulating blood, and in the relative density of its several portions.[o]

The second point of importance in the fitness of the blood for absorption, is its rapid *motion.* This is very much dependent on the nervous system, and therefore has a more intimate relation to animal life than the other circumstances. Nerve acting on muscle originates the pulse-wave from the heart, and the immense importance of that wave to the maintenance of the circulation is familiar to our daily thoughts. It may be compared to flushing the drains for the removal of obstructions, only here the flushing takes place sixty or seventy times a minute, instead of twice a-day, as in the sewers. But the instantaneous phenomena of blushing, paling with fright, and other examples of the power of the mind over the minute vessels of the skin, seem to show an influence of the nervous system as the mind's instrument over the capillary circulation, as well as in the visible vessels. For it must be remembered that in this the pulse-wave has ceased, as the familiar sight of the frog's web shows us. Although other causes for the circulation may be mentioned, the most obviously powerful one is the direct or indirect action of nervous energy. Now this may fail to effect its purpose in two ways,—either from the obstructions it meets with being greater than it is able to overcome, or from being itself unequal to the task from weakness. Hence we have two great classes of circumstances which originate disorders of the circulation: those where something stands in way of its usual course, such as viscera altered in shape or consistence, and those which divert the nervous force, or injure the agents by which it acts. These are very numerous, indeed there is scarce any derangement of the human frame in which the circulation can be said to be entirely unaffected, and in which, therefore, the part it plays in absorption is not interfered with.

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[o] Heller's *Archiv*, Bd. iii., s. 520.

The third point mentioned, the *alkalinity* of the blood, is subject to the constant drain of the secretions and excretions, the composition of which requires a daily supply of soda, equal to the whole of that circulating in the vessels. Indeed, the calculations of Drs. Bidder and Schmidt show that for the formation of the bile, saliva, pancreatic and intestinal fluid, to say that half as much again as the blood's soda is required, would be nearer the mark.* When things go on in their regular course, the greater part of this is taken up again by re-absorption; but should the secretions be disturbed, the alkali is either unnaturally detained, or else lost. If they are diminished in activity, it remains in the blood, if they are too copious for the absorption, it is entirely excreted and wasted.

Circumstances which modify the secretions are so numerous, that we should expect *à priori* considerable variation in the amount of circulating alkali. And such is the result of observation. Some articles of diet add to the soda, bleeding removes it; some diseases augment, some diminish it.

As instances of variation we may cite the following:—

M. Plouviez, a strong healthy man, took, in addition to his ordinary allowance, two and a half drachms of common salt every day for three months. Analysis of his blood made by M. Pogiale showed the carbonate of soda and potass as constituting 0·48 parts in 1000 before the commencement of the experiment, and 0·56 after its conclusion. This increase of the salts, moreover, not being due to an augmentation of the fluids, and substances soluble therein, but being coincident with a proportionate increase of globules, fibrine, and fat, and a decrease in the water, the amount of the latter having sunk from 779·92 to 767·60.†

The effect therefore of taking salt is to increase the general amount of alkalies circulating in the blood.

Now of bleeding the effect is not only to diminish them *absolutely*, but to diminish them also *relatively to the neutral chlorides.* Thus Dr. Zimmerman found in one experiment for example, that in a portion of blood taken at the commencement of a bleeding, the proportion of other salts to the chlorides was as 2·12 to 3·97, while in a portion taken at the end of the bleeding the proportion was only as 1·98 to 4·40. The result was found almost identical in several repeated trials on various patients. The diminution and increase, therefore, of the alkaline salts seems to run very much hand in hand with the diminution and increase of the globules in artificially induced conditions.‡

In disease also the same sort of changes have been observed. Thus Dr. C.

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* *Die Verdauungssäfte*, s. 410.

† *Comptes Rendus de l'Académie des Sciences*, vol. xxv., p. 109.

‡ Heller's *Archiv*, Bd. iii., s. 522.

Schmidt, in his elaborate work "On the Chemical Characteristics of Cholera," proves by analysis the absolute diminution of salts in the blood of patients affected with that epidemic, whilst in those affected with diarrhœa as distinct from cholera, the same diminution is not observed. I do not think Dr. Schmidt himself makes any allusion to the variation of the relative proportions of the salts among themselves, but if his numbers are added up, it will be found that the chief deficiency exists in the soda, and consequently in the alkalinity of the blood. Thus, in the analysis of the blood of a healthy man, bled for some mechanical injury, the proportion of the chlorides to the alkaline soda was, in 1000 grains of blood, as 4·763 to 0·921: in that of a woman aged twenty-six, affected with cholera, in 1000 grains the chlorides were 3·938, the alkaline soda 0·480.—(Analyses—of healthy blood, No. I.—of cholera blood, No. III.)

The converse however is not the case, that is to say, that an increase in the proportion of saline constituents does not necessarily involve an increase in that of the soda. Thus, in the blood of a man with chronic dropsy and albuminuria, in 1000 grains the chlorides are 5·806, the soda 0·627. The blood of the two diseases, widely as they differ in that in one the salts are diminished and in the other increased, agree in this, that the alkalinity of the blood is defective. (Analysis No. IV. of dropsical blood.)*

The minds of all who have received a scientific education have during the last few years got pretty well used to the notion, of the passage through solid membrane of matters in a fluid state miscible one with the other, which is indicated by the term "Endosmosis." But the question arises whether we are to limit the passage to miscible matters, nay, whether we are to limit it even to fluids? Experiments lately made promise to extend much our ideas on these subjects. Those relating to the transmission of oily matters through the wet walls of the intestines will be more in place after we have reviewed the construction of those walls, inasmuch as it is only in that part that any observations have been made concerning it. But membranes in general, not excepting the external skin even, are more than suspected to have the power of allowing not only immiscible fluids, but even solid powders to pass through them without lesion.

Our knowledge of the passage of insoluble matters through organic membranes, was first inaugurated by Œsterlen, who found that charcoal minutely powdered, when given in food to animals, got into the blood, and was there detectable by the microscope, and also that metallic quicksilver passed through the skin into the circulation in a similar manner. His experiments were repeated in 1847 by Dr. Eberhard with the same result; finely divided sulphur being employed in addition to the quicksilver and charcoal. Messrs. Mensonides and Donders repeated them again successfully, and moreover succeeded in actually seeing, under the microscope, a starch globule pass unbroken through the coats of the mesaraic vein of a frog.*

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* *Charakteristik der Epidemischen Cholera*, von Carl Schmidt, ss. 37, 41, 127.

The deductions from these experiments are certainly very subversive of our ordinary notions of solids and fluids; but the question arises, whether our ordinary notions are fairly justified by facts? We manifest no surprise at a needle's point penetrating a skin with ease. But the fine dusts employed in the above-mentioned experiments are infinitely smaller than the finest needle's point. All that is wanted, then, is a pressure from behind or an attraction in front to cause them to go through. Our efforts must be directed to discover such a pressure or such an attraction.

Is this, however, a greater shock to our ideas of solidity than the molecular changes in the interior of wrought iron, so disagreeably forced on our notice by railway accidents? Or, to pass from microscopic to telescopic objects, are not the observations of Messrs. Agassiz and Forbes, on the river-like flow of unmelted glacier ice, equally contrary to the established picture of the stability of solid forms? Truly we should not be unwise to consider the matter as at present an open question, and exclaim, with the poet of philosophy,

> " Usque adeo in rebus SOLIDI NIHIL esse videtur!"

It is quite true that the instances above cited exhibit the passage of insoluble bodies through membranes only under extraordinary and exceptional circumstances—under circumstances, too, which are artificially brought about; but still we do not know how far they do not, and how far they do, resemble the ordinary conditions of life, or in what respect the experiment differs from the physiological action And until we know that, we must not pass by these facts without serious notice.

We have thus been considering the importance of the bloodstream to absorption, arguing from what is known of the general laws of that process. If the argument from final causes has much weight with us, the same impression will be confirmed by the intention which is displayed in the anatomical structure of mucous membrane. The bloodvessels are so arranged as if it were considered an impossibility to expose them too much on the surface. No means consistent with their safety could be devised which would subject them more completely to the influences exerted on the outer side of the membrane, than those which we see to be employed.

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* *Eberhard's and Donders'* Papers in Henle's *Zeitschrift für Rationelle Medicin.* 1851. p. 406.

Throughout the surface a velvet pile of nipple-like projections (*papillæ*) rise, each nipple furnished with its own knot of capillary artery and veins around, thus doubling, quadrupling, or increasing tenfold, in proportion as the papillæ are short or long, the distance the blood has to go in proceeding from one point to another. In the external skin, the interior of the lips and cheeks, &c., these papillæ are so small, and are plastered over by such a thick layer of epithelium to guard them from injury, that they do not exhibit themselves publioly; but on the tongue they are very stout and long, and show in an exaggerated form the state of things we have to imagine for the rest of the surface. Varied very much are the details of form adopted to accomplish the same end without interfering with the offices of the parts, but the principle is always the same—of exposing as great a length as possible of minute vessels. Where papillæ cannot be placed, an intricate web of capillaries still occurs, presenting an appearance to the naked eye, and suggesting an image to the reason, only differing in degree from the more highly developed absorber.

That the papillæ minister also to the common sense of touch and to the special sense of taste, by containing nerve fibrils, and projecting them into the free space, is beside the present question. They are equally elaborated and perfect where such a purpose is not fulfilled by them, and where their chief office, perhaps their only office, is absorption—I mean in the intestines.

SECTION C.—*The Mucus.*

I have been speaking hitherto of mucous membranes, their parts and their characters, but I have not yet mentioned that character from whence they derive their name—namely, the fact of their being covered with mucus.

What is mucus? where does it come from? and what is it for?

I have always been sorry that we did not, like our German relations, keep to the old Teutonic word "slime" (*Schleim*). The use of the Latin leads us to expect a scientific accuracy of meaning which further acquaintance does not discover. We look to the chemist for an analysis of it, and to the mycroscopist for an account of what he sees there in its normal condition. But the first doubts about one of the most obvious properties; he does not know whether, with Andral,[*] to say that real pure mucus is acid, or to consider as a necessary part of it the soda contained therein, and to pronounce it alkaline. The other shows us a number of variously shaped bodies in what we have called mucus. These bodies occur in varying proportions, sometimes one sort constituting the greater part of the solid contents of the liquid, sometimes another existing in the same excess, but apparently in the natural condition never absent. Some of them are evidently scales from the surface of the epithelium which they cover, differing in form according to the part they come from: others bear a close resemblance to the same scales in a youthful condition, such as we see in the deeper layers of the membrane—namely, round balls consisting of a congeries of transparent grains, like a sphere composed of beads of jelly, with one nucleus or large bead in the centre, whose outline is more distinct than the other. They are so constantly present as to be called "mucous globules."

The slightest irritation, perfectly consistent with health, causes not only a vast increase in the quantity of water and the salts it holds in solution, but alterations in the proportion which these elements bear to one another. The doubt arises whether these epithelial and "mucous" globules are to be considered as essential parts of the mucus, and to be analysed and described with it, or whether they are to be looked upon as accidental. The question is much the same as whether, in reckoning the population of an inn, you would include the travellers or not, which of course depends on the object you have in view in making the estimate.

Those who consider the globules as accidental, are rather driven to straits to find mucus to describe. Dr. Lebert says he could get none except in one case, and that from some of the muciparous glands at the neck of the womb, morbidly obstructed. I do not think this is to be viewed as a fair specimen, for the glands were hypertrophied, as well as deprived of their usual free opening, and we are not told that the fluid performed any of the duties of the natural secretion.

The same objection lies against some experiments by Dr. Scherer, made upon mucus taken from an enlarged bursa mucosa lying between the trachea and œsophagus. The observations made upon this do not necessarily apply to healthy mucus. Neither do those made on the contents of enlarged Nabothian glands, nor Berzelius' analysis of the produce of a cold in the head.

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[*] *Comptes Rendus*, tom. xxvi., p. 650.

Dr. Tilanus views the mucus and the epithelium as mutually dependent upon one another. Wherever mucus is present, there in truth we find epithelium lining the solid tissues adjacent, even in pathological structures, as is stated by Professor Rokitansky in the instance of cystic tumours. But the converse of the proposition, namely, that where epithelium exists there is always mucus, cannot be maintained; the familiar tubules of the solid glands, such as the kidneys, are against it.

Dr. Tilanus quotes Virchow as unable to distinguish between mucous globules and young epithelium.[*]

Subtle refinements of definition are not necessary in science; so that no harm will be done by the vagueness of the term "mucus," if we only take care to remember that it *is* vague;—and if, with the knowledge that the chemical and other observations upon it are made under great disadvantage, we rest our considerations as much as possible on its obvious and certain qualities. We see it is a glassy, half-jelly like fluid, easily drawn into tough threads with great powers of cohesion, and that it thus forms a sort of elastic semi-solid. It rapidly absorbs a great deal of water, and swells up, but is not soluble, and only sparingly diffusible through the water. There are contained in it a great number of scaly and globular bodies, as above stated; these are in some degree, at any rate, the cause of its tenacity, for in health, and under moderate irritation, it is tough and stringy in proportion to their number. It is therefore by no means a simple secretion. It would seem as if a dilute saline exsudation had dissolved those scales which were not too hard or horny, and that even these sometimes get washed off also. Hence we find it holding in suspension mechanically mixed with it nuclear structures, called mucous corpuscles, often half corroded epithelial scales, and other granular bodies which so strongly resemble the parts we see in perfect cells, that they are naturally set down as the débris thereof. The physical properties perceptible to the sense of touch which mucus exhibits in different parts, apparently depend on the variable amount of these constituents.

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[*] Lebert *Physiologie Pathologique. De l'Inflammation*, p. 66. Tilanus, *De Salivâ et Muco*, p. 73, et antea. *Scherer*, quoted in Lehmann's *Phys. Chemie*, bd. ii.. "*Schleim.*" Rokitansky, *Pathol. Anat.*, i., p. 315.

Mucus is formed in two ways: in *special glands*, or on the *free surface*. In the former case it is very usually mixed with some of the peculiar solvents known to exercise their properties on alimentary matters submitted to them; the peculiar solvents of the latter either do not exist, or at any rate have not been pointed out.

The moderate diffusibility of mucus assists it in being gently spread over the surface without being liable to be washed away entirely, as it would be if it were easily soluble in water. This is a matter of no slight importance, for though copious as a whole, the amount of mucus formed by each individual portion of membrane in health is very small, and the loss of it cannot be afforded.

Spread thus over the membrane, it extends from one follicle or gland to another, and pervades the whole, without any necessity for its being supplied by the epithelium between the follicles. It is probable however, that did the necessity exist, it might be furnished from that additional source, for several parts quite devoid of the usual manufactories of the secretion are still well covered with mucus,—for instance, the frontal and sphenoidal sinuses, the antrum of Highmore, and the synovial sacs. These all, as Dr. Tilanus observes, possess epithelium, as indeed do all normal mucous membranes; and I think there is every reason for agreeing with him in associating together as cause and effect that substance and the fluid we are considering.

Of the use of mucus as a solvent of organic substances, or rather as a chemical cause of their becoming soluble, especially in the digestive canal, it will be more properly the place to speak when we come to that part of the subject which relates to the *preparation* of substances for absorption. What has to be noticed here is the manner in which it keeps the parts devoted to that duty capable of, and efficient in their work. Its tenacity, slipperiness, and elasticity, certainly are a great defence for the delicate epithelium against such mechanical or chemical injury as it may be subjected to.

This is obvious enough in the neighbourhood of all the outlets in the body. Our sensitive nerves quickly give us warning when mucus is wanting at any of them. When at the commencement of an inflammatory state none is formed, in the nose or urethra for instance, the in-draught of cold air through the first, or the passage of urine through the other, is painful in a greater or less degree. When afterwards so much water is poured out that the mucus is washed away, or when it is rendered less tenacious than it ought to be by the admixture of pus, and so easier removed, pain of another sort but sufficiently commemorative of the deficiency is experienced. We are not likely to forget this use of mucus, if we reflect on it and read about it during a cold in the head.

The great quantity of water it is capable of retaining, by swelling up, assists in keeping constantly damp the membranes over which it is spread. Thus is fulfilled one of the first essentials to the process of endosmosis or absorption. The same instances as above given will remind us of this point also. When we have a nasal catarrh the slightest dryness of the air parches up the nostrils, though a few minutes previously they had been dripping with moisture.

Thus the integrity of the membranes and their power of absorption are in no slight degree maintained by the mucus.

There is another use of mucus, which is not indeed connected with digestion, and perhaps therefore is a little out of place here, but which I should like to mention, because it appears to me very important, and I do not find it usually thought of. The membranes which furnish this secretion seem to be placed as *safety valves to morbid action.* A man gets his feet wet, and in consequence an uncomfortable state of blood is produced, which he feels all over: a good cold in the head comes out and sets things to rights. Or he absorbs the poison of cholera from air or water,—a diarrhœa arises, which, if the patient's strength can bear the remedy, effects the cure. Worse things happen if these natural terminations are prevented. Inflammation of bone is a terrible disorder, so in parts of the osseous system ill-defended from changes in temperature and other causes of injury, cavities lined with mucous membrane are provided, in which temporary morbid action can occur without any very serious inconvenience. Such are the frontal and neighbouring sinuses, the cavity of the tympanum, and in a minor degree the synovial sacs of the joints. The interstitial inflammation of visceral glands which is so likely to end in abscess, such for example as of the liver or kidneys, may be often prevented by purulent secretion at their outlets, and the proneness of the bowels to diarrhœa will account for the infrequency of peritonitis.

We may discover the reason for the frequency with which the mucous membranes are made the outlets for morbid action, in the very slight comparative injury which it there produces. In a catarrh the capillary bloodvessels become distended and clogged up without much pain, mucous globules are poured out in excessive numbers, fibrine forms, and is washed away in small flakes, pus also mixes with the mucus, and is easily diffused through the copious stream of water which is pouring by, without any harm to the surrounding textures at the time, or any permanent alteration of tissue. Whilst if the same series of actions are gone through anywhere else, we have racking pains, fibro-purulent deposits, abscesses, and fibrinous cicatrices are left behind when all is over.

The wise physician imitates nature in this particular as in many others, and does not mind producing all sorts of disturbances in the mucous membranes by means of his drugs, if by so doing he can prevent other injury. He knows that the mischief he makes will soon cure itself, while that which he stops is dangerous to life or comfort. The idea of the effect of treatment on the mucous membranes cannot be too often presented to the mind. It may serve as a counterpoise to that delusion even now so prevalent among medical men, of calculating on the action of medicines only in so far as they are absorbed into the blood. I have no doubt on my own mind, not only that many substances have through the mucous membranes a powerful influence over the constitution without being dissolved in the blood at all, but that many of those which are so dissolved still owe their chief strength to their effect on the tissue we are speaking of. This subject will be returned to in a future part of the volume.

SECTION D.—*The Water.*

Although the membrane we are considering receives its name from the mucus which it forms, that is not the most prominent or copious of its clothings. We put our fingers on such a surface and very likely we carry away no mucus on them, but they are sure to be wetted: there is no part of the membrane where they escape that. The quantity of water poured out is very striking. If you turn down the lower lip before a mirror, and wipe it quite dry, you may see and feel a number of seed-like little glands studding the surface all over. In a few moments each one of these protuberances is headed by a tiny drop of dew, which grows rapidly larger, till in a short time the whole lip is again covered with moisture, as before. The busy scene carried on under our eye on this small scale is impressive in itself, but becomes much more so when we consider the great extent of mucous surface. Reckoning it with Lindenau at twenty-four square feet, the square inch you are looking at must be multiplied by 3456, to make the resemblance fair. And as the secretion is in many, indeed in most, places more abundant than here, that idea would still be under the mark.

The whole amount of water given out by the mucous membrane is by no means destined to be wasted. We see how quickly it exudes, and we know by the amount of our fæces that in health it does not pass off by the bowels, into which it is thrown. What becomes of the several gallons a day which our imagination can easily picture to us is secreted from this active source?

The argument carried on through all the previous pages of this volume explains without difficulty what in truth is the destination of the water so bountifully poured forth. We have seen that however well the mucous membrane may be constructed for purposes of *secretion*, it is still better constructed for purposes of *absorption*, and that water, however quickly it is supplied, will rapidly be carried off—will be carried off indeed with a rapidity very closely proportioned to its quantity. For in referring to what has gone before, we have seen reason to believe that it is the very dilution of the liquid on one side of the membrane compared with that on the other—the watery state of the contents of the bowels compared with the blood—which is one of the great incentives to activity of endosmosis. The intestinal canal is to be conceived as drinking up not only the fluid we swallow as food, but also those which it makes itself for its own consumption. What the amount of those is will be best seen by a tabular sketch of the probable (say maximum) quantities of each separate secretion poured out directly or indirectly on to the membrane. An adult man weighing about ten stone is calculated to secrete in twenty-four hours weights approaching nearly to the undermentioned,* viz.:

Of saliva . . .	3 to 4 lbs. avoirdupois, containing of water per cent.	. . . .	99	pts.
Of bile	3 to 4	. . . .	95	"
Of gastric juice . .	14 to 16	. . . .	97	"
Of pancreatic juice	½	. . . .	90	"
Of intestinal juice .	½	. . . . (conjecturally)	97½	"

Thus making a total of from twenty-one to twenty-five pounds, of which, as we see, nearly ninety-six per cent. is water, and of which only so much passes away with the fæces as will prevent them from becoming too solid.

The preceding calculations are derived from the elaborate work of Professors Bidder and Schmidt, of Derpt, *On the Digestive Juices.* They are based on the assumption, which carries with it every appearance of probability, that animals whose food is naturally the same, secrete the same amount of digestive fluids in proportion to their weight. The only secretion on which this assumption could be tested was the saliva, and there it was found to hold good; for the quantity formed by the glands of a dog during an hour was just about one quarter of that which ran from the mouth of a man four times the animal's weight in the same time. It ought on the other hand to be recollected that it is very possible that other circumstances besides the nature of the solid food may affect the quantity of the digestive juices.

Taking, however, this assumption as correct, dogs were artificially placed in the same circumstances as the Canadian upon whose person Dr. Beaumont made his observations on the stomach—fistulous openings were made into the several parts from whence the secretions could be collected, and the animals kept alive and in health under various modifications of diet. The subjects of experiment probably did not suffer much from the operation, and may be considered as fair samples of average health. Judging at least from the fact that Dr. Beaumont's man was able to undertake the laborious occupation of a Canadian *voyageur*, exposed night and day to all the inclemencies of a severe climate, drunken habits, and violent bodily exertion, with a hole still in his stomach, there seems no reason to doubt that these dogs could have done ordinary canine duty, if called upon.*

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* Altered to suit the present subject from Drs. Bidder and Schmidt's table, *Die Verdauungssaefte*, last page. In a future part of this volume reasons will be given for believing that in the case of the gastric juice this estimate is even under the mark.

The error, if there be one, is more likely to be that of defect than excess, for it must be remembered that animals in the unnatural state of comparative disease, which these fistulous openings must induce, certainly have their secretions diminished. In the dogs experimented on by Drs. Bidder and Schmidt, where the strength and weight fell off, the amount of bile made by them was invariably less; and the same was observed too in the flow of gastric juice from the stomach in Dr. Beaumont's patient. When he was feverish or dyspeptic the flow was partially or entirely arrested †

The clearest notion we can gain of the business performed by all this ten or a dozen quarts of water which exude on the mucous membrane of the intestinal canal, and are by the same membrane taken up again, is by viewing them as a *circulation*. It is constantly going its rounds like an endless chain, finding and taking up inside the solid structure of the body substances which ought to come out and be got rid of, finding outside nutriment which the body wants, and conveying it in.

Truly, when a man contemplates with the eye of the reason this unceasing journey, this great current so entirely removed from the cognizance of our senses, he is at first confounded with the novelty of the ideas it excites, *ingenti motu stupefactus*

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* The question of the right we have to perform experiments on animals is not an easy one. That it is cowardly and savage to torture them for our mere amusement may be at once conceded; the nauseous brutalities of Mr. Gordon Cumming, and the wholesale impalement of butterflies by young ladies, are beyond rational defence. So, too, was the reckless carelessness about life shown by M. Magendie in the illustrations of his lectures. But when real knowledge is to be gained which will in the end lengthen the lives and relieve the pains of men and animals, when such knowledge can be gained no other way, and at the same time the experimenter feels that he is *the man* called upon to gain it, I should not be his accuser. More especially since the discovery of the production of stupefaction by ether and chloroform renders operations painless for a time to the animal employed. But for medical practitioners, whose duty is to keep the relief of pain uppermost in their minds, or for amateur dabblers in science, to run the risk of hardening their hearts by such experiments, seems unjustifiable.

† *Die Verdauungssaefte und der Stoffwechsel*, von Dr. F. Bidder und Dr. C. Schmidt, Professoren in Dorpat. Mitau und Leipsig. 1852. *Medico-Chir. Review*, July, 1853. Beaumont: *Experiments on the Gastric Juice and Physiology of Digestion.* Boston, 1834.

aquarum, and almost refuses to receive them. It is highly important, therefore, to bring it frequently before the mind till it becomes habitual, for there is no view of living phenomena so practically weighty for the medical man.

The germ of the idea of a circulation through membranes may be found in that strangely worded collection of suggestive thoughts,—Emmanuel Swedenborg's *Animal Kingdom* (chap. xvi. § 325). He applies it to the serous sacs principally, or to what Dr. Schmidt calls the "circulation of serous diffusion," for the state of physiology in his time did not enable him to see its application to the mucous membranes. The unintelligible language in which they are couched has hitherto concealed this, and perhaps still conceals many another brave idea.

A further expansion of it is to follow the different elementary constituents of the body, oxygen, hydrogen, carbon, nitrogen, sulphur, sodium, chlorine, iron, &c., through the chemical changes which they undergo again and again without leaving the body. Coming out, for example, as chlorine does, in a free acid in the gastric juice, or as an alkali, as soda does in the bile, and going in again as a neutral salt.

Carried on still further, it leads us to the body's connexion with the outer world. We may view in this light the taking up of substances,—such as water for instance,—by the skin and other parts, its passage through the body, and its expulsion unchanged by kidneys and lungs again to be vapourized in the air, and taken in pure by other or the same individuals, till

> "Each minutest drop of rain
> That hangeth in the thinnest cloud,
> Has flowed through living veins."

And in a similar spirit we connect the body with external nature by substances which, as above instanced, go in under one form and go out under another.

The remarkable circulation of substances unchanged in chemical character may be called the CIRCULATION BY DIFFUSION, inasmuch as it appears to be in accordance with the laws of diffusion that the circle is carried on. It may be divided into the GENERAL CIRCULATION BY DIFFUSION, in which the body forms part of the whole system of nature, and the INTER-

MEDIATE CIRCULATION BY DIFFUSION, which takes place inside the individual. That distinguished by chemical change may receive the name of METAMORPHIC CIRCULATION, and may, like the others, be divided into GENERAL and INTERMEDIATE.

What we are now concerned with is the *intermediate circulation by diffusion*. In it other constituents of the animal frame, besides the water before mentioned, circulate in the same way, going out and in unaltered, as, for instance, sea salt and other diffusible salts. Their business may, like the water's, be conjectured to be that of carrying other substances in both directions. Their actual amount is insignificant when compared with that of the water; and relatively also to the quantity of salts contained in the body it is small. Thus, while the water of the body is calculated at 680 parts in a 1000, and the salts at 59 parts in a 1000; of these 680 parts 23 to 47 per cent. circulate through the bowels, and of the 59 saline parts only from 8 to 17 per cent. so circulate.*

We see then that as regards quantity the water evidently plays the most important part, and of the use of the water we are enabled to gain the clearest notion by means of the investigations of physical philosophers, while of the duties which the salts perform we cannot learn much from the present state of science. This will account for the prominence of the former in the ensuing pages.

One great duty, if not *the* great duty of the circulating intestinal water, is to carry in to the bloodvessels, and other parts able to receive them, all substances that it can dissolve in its passage. It does this in some parts of the mucous canal more than in others, from a variety of circumstances which will be pointed out when we come to the differences of absorbing membrane in several parts. But as a general representative of this act we may still take the mouth, so ready at hand and so easily looked at and experimented upon.

We smoke tobacco for a few minutes, and afterwards, in spite of all the washings we administer to the mouth, the smell is exhaled, because the air from the lungs is impregnated by the essential oil. There is no other way in which it could have got from the mouth to the lungs, except by the veins. We chew turpentine, garlic, asparagus, or one of the many other plants containing a strong essential oil, taking care not to swallow any, and the scent is soon perceptible not only in the breath but in the urine. When a surgeon has been performing a *post-mortem* examination, the quick-scented members of his household can detect the cadaverous animal odour he expires. These instances of absorption by the veins of the mouth and lungs are given not as proofs, nor as the most perfect examples that could be found, but simply as the most familiar to daily observation. The subject of venous absorption has received much attention from physiologists at all times; and what has most recently been added to our knowledge by the labours of Dr. Bernard will be given in a future page.

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* See Bidder and Schmidt's work above cited, pp. 400 and 402. Decimals are omitted and the nearest whole numbers taken.

SECTION E.—*The Nerves of the Alimentary Canal.*

Proof of the power of mind over the secretions is quite unnecessary; we have all experienced the hot sweat of anger, the chilly damps of fear and disappointment, the flow of saliva at the thought of food when hungry; and can easily convince ourselves by personal observation that these do not arise from muscular motion squeezing out the fluids in an increased stream, but really from an augmented quantity of it. The opportunities which physiologists have had of viewing the interior of living animals, enable us to know that the same causes produce the same effects in the internal as in the visible organs. At the sight of meat the formation of gastric juice in the stomach is increased, as has been seen, not only in dogs, but in the patient observed by Dr. Beaumont with gastric fistula.

The deranging effects sometimes caused in the liver by mental causes are sometimes very remarkable. Dr. Macleod used to relate in his Lectures on Medicine at St. George's Hospital an instance he himself saw of a young lady who had been privately married, when accused of being pregnant, instantly becoming jaundiced—not by a long process of dyspepsia, but forthwith. Now the experiments of Drs. Bidder and Schmidt (*opus citatum*, p. 209), showing the non-contractility of the gall-bladder and ducts under the influence of electric and other stimuli, exclude the idea of such cases being due to any muscular motion, and refer us to the immediate influence of the mind through the sympathetic system over secretion.*

We see thus the effects of the *presence* of nervous or mental influence in augmenting, diminishing, or deranging secretion: to make the crucial experiment of testing what those are which follow its *withdrawal*, is a more difficult matter. The sympathetic system has so many small independent centres of action, that it may be naturally supposed impossible to separate it entirely from any part, without so destroying the structures as to render secretion impossible. The effect, however, of cutting off that connexion which exists between the two sorts of nerves in the pneumogastric or vagus branch, may be tested by dividing the trunks of the nerve in the neck; and this operation has often been performed on animals for the purpose. Unfortunately, however, the accounts given of its consequences are rather discordant, and no certain result is arrived at; some experimenters reporting that secretion entirely ceased, and others that it continued unimpaired.

It is very possible that the variations observed in the phenomena attending division of the vagi may be in fact due to differences in the mode of performing the mutilation, and that the persistence or not of gastric secretion may depend also on collateral circumstances, such as the affection or not of the diaphragm, abdominal and costal muscles, &c. The four cases reported by Drs. Bidder and Schmidt are pretty uniform, the operation having been completed in the same manner and under similar circumstances. The subjects consisted of four dogs with gastric fistulæ (in fact the same as they had before quoted in the experiments on the solvent powers of the gastric juice), and the general account given of the effects which ensued is as follows:

"The division of the vagus nerve in no wise takes away the sensation of hunger. The animals operated upon by us took during the first two days the food that was given them with nearly their usual appetite, and the feeling of thirst was (for reasons which will shortly be mentioned) excessively increased. It may be observed, that during these two days the prostration afterwards caused by the mutilation had not commenced. Of the food and drink taken, however, but little if any arrived at the stomach, as was easily seen through the fistulous hole. On the contrary, the matters swallowed were, even during the time of eating and drinking, generally returned by vomiting; so that it often happened that the animals, without doubt pressed by hunger and thirst, repeated on the matters thrown up the operation of swallowing as many as fifteen or sixteen times, till they were quite tired and gave it up, to begin again after a longer or shorter pause. All those symptoms seemed to us, without any doubt, to depend on the paralysis of the lower part of the gullet, arising out of the division of the vagus nerve in the neck. The stomach certainly had nothing to do with them, for the matters vomited had none of the acid reaction which would have distinguished them under those circumstances.

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* I have assumed here what possibly some may be found to deny, that the mind acts on matter solely through the nervous system. A note is not a place to argue so important a question.

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"The movements of the stomach were in no case destroyed; on which points certain proof was obtained in several ways. In the first place, the instrument inserted into the fistula to draw off the gastric juice was moved hither and thither quite independently of the breathing. Then on inserting the finger into the hole, it was felt to be squeezed, and the solid aliments introduced into the organ by the opening were carried forward in the usual manner. These experiments seem to us an unavoidable proof that the nervus vagus in the neck does not harbour any of those elements by which the muscularity of the stomach places its ordinary actions in connexion with the central organ, although the fact still remains, that by stimulation of the nerve in the neck muscular contractions of the stomach are developed.

"As respects the secretion of gastric juice after the operation, we have to look first to the quantity of it. This, unfortunately, is not decided by the experiments, for in two it seemed to be much diminished, and in two but little altered."

However, the positive fact of its continuance, even in some cases, outweighs several negative results, which may have depended on other circumstances. In one case the secretion continued for four days, and then ceased, apparently in consequence, as Dr. Bidder thinks, of the deficiency of water in the animal body, caused by the constant vomiting. This fact he gets evidence of in the comparative want of aqueous constituents, and the proportionate excess of solid matter in pieces of muscle and lung from the animal, which were dried and weighed. *Indirectly* only, therefore, but not *directly*, the removal of the connexion with the brain seems to affect the quantity of the secretion.

As respects the chemical constitution, in the proportion of acid and of other elements no variation from the ordinary condition could be detected.

On the physiological action of the gastric juice after the division of the pneumogastric nerve, seventeen experiments in five series were made in the Derpt laboratory, of which the results may be given in Dr. Bidder's words:—"If we observe that the animals employed in these researches, which, before the operation had already been used for other experiments on digestion, had yet dissolved in periods of two hours' duration on an average 29 per cent., in four hours a mean of 62, and in six hours 76 per cent. of the albumen submitted to the test, amounting to an equivalent of 26, 45, or 65 hundredths of the solid constituents of the same—if we observe this, we can have no doubt that the solvent powers of the stomach on albumen taken as food is not annulled by breaking the connexion of the pneumogastric nerve in the neck, but that still it is considerably diminished in rapidity.

"This latter result may with good reason be attributed to the lessened proportion of the secretion, which, if not indirectly caused by the shock of the operation, and an unnecessary consequence thereof, yet is the only change in the activity of the stomach which arises from the division of the vagi nerves."*

The natural inference from what has gone before is, that the agency of mental emotion over secretion depends most probably upon its direct action on the sympathetic system of nerves, and that it has therefore but little relation to its communication with the brain.

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* *Die Verdauungssäfte*, 90—97.

This is quite in accordance with what we may deduce from the distribution of the cerebral nerves, for we may notice, that psychical agencies affect secretion by no means in proportion to the quantity of fibres from the brain which proceed to the parts exhibiting the phenomena.

We may trace the unconscious consent of unsophisticated mankind to the direct action of the mind on the sympathetic system, in the phrases of ancient nations. The Hebrews speak of "*stomachs* for the fight," "*bowels* of compassion," "the *breakings*" of fear, the "*heart*" and the "*reins*" of desire: the Greeks adhere more to the circulating system, so that Homer's heroes have *livers* boiling with black rage (? portal blood) and *hearts* affected with all sorts of emotion, but of its effect on the alimentary canal we do not read so much. Aristophanes and Persius associate mirth with the *spleen;* I suppose, because the natural effect of "Laughter, holding both his sides," is to give a pain in the situation of that viscus. Our language makes it the seat of different feelings, but the ambiguity of this organ's functions has never made it a favourite. Vague, indeed, is the assignation of the attributes to various parts in diverse tongues, yet *the older and more natural the phrases, the more commonly they connect the passions and the abdominal viscera.*

The alimentary canal is not wholly devoid of common sensibility. Pressure on the abdomen is felt in the bowels, sore parts are tender, and distention causes immediate pain. Yet compared with the vividness of those conveyed by the external skin, its impressions are faint. Those indeed are so strong, that when both occur together they overpower entirely the weaker sensations and render us unaware of their existence. In this way has the fallacy gained ground, that the abdominal mucous membrane is absolutely insensible. In the vivisections of animals called to evidence the want of sensation, such a shock is caused by the operation to the general nervous system, that no other impression can be communicated at the same time. And so the scraping and cutting of the stomach and bowels give no perceptible pain, the lesser being masked by the greater, just as in the children's experiment of taking out a hair unperceived by the owner, when the head is struck with the other hand.

The nerves of the alimentary canal are not pleasurably excited as are those of taste by various food. Heat and cold, tickling, and the stimulus of rubefacient substances, such as pepper, mustard, and the like, seem to be the whole of the agreeable sensations they can communicate. But they are very ready to warn us, by pain and discomfort, when any of the digestive process is growing wrong. A healthy man seems entirely ignorant that he has got any bowels, but an invalid is most unpleasantly apprised of the fact.

The abdominal nerves, too, become sensible of a class of impressions unknown to the cuticle. Not only does unusual stimulus give pain, but the absence of the usual stimulus also. Hunger, for instance, and the non-secretion of the gastric juice, may amount to absolute agony. The ordinary chemical decomposition of matters which ought to be digested is uncomfortable to the alimentary canal, though the touch would fail to discover it. The over secretion of mucus and its passage down the canal cause a sensation, though to the touch it as smooth and unexciting as chyme or food.

This absence of sensation in the healthy state and its presence in unnatural conditions, render the impressions conveyed by the sensitive nerves of the alimentary canal a matter more related to the derangements than to the physiology of digestion.

Differences of Nervous Action in various localities of the Alimentary Canal.

The organ of taste is not only useful in enabling us to distinguish what we are eating, but it also, by its excitation to agreeable sensations, brings the mind into a state in which it is least likely to interfere injuriously in digestion. For it is to be observed that the less the attention is drawn to involuntary acts of the body, the more regular and normal they are; and it is indubitable that the concentration of the mind upon the circulation, breathing, and in a less marked degree upon digestion, certainly deranges them.

As the nerves of taste pass through the glosso-pharyngeal and fifth pair of bundles directly to the brain, the impressions of this sense are immediate, like those of all cerebral nerves, and long anticipate any sensations derived from the food in the further part of its course.

In the œsophagus the sense of taste ceases, and all the impression conveyed direct to the brain is that of a dull common sensibility, whose feelings are fainter and fainter as we get lower down, till in the lower third it appears, in a healthy state, entirely annulled. This is an experiment that any one may try upon himself.

But the œsophagus also conveys to the mind sensations derived from the sympathetic system. Thus hunger and thirst are felt in the gullet and back of the fauces, though, as is shown by the experiments previously detailed (page 40), they are not in any way dependent upon the vagus cerebral nerve. It receives also from the sympathetic system the impressions which cause the sensation of nausea when emetic substances are taken in, or an overload is felt in the stomach.

The sympathetic nerves of the stomach are those which convey to the mind the impressions of hunger and thirst. This is shown by the immediate relief to those sensations experienced when food has got into this organ, and before any calculable amount of it could be absorbed. It will be observed, too, in a future portion of this volume, that it is from diseases of this organ that erroneous impressions on this subject are originated. False hunger, false thirst, unnatural absence of appetite for food or drink, can usually be traced to its unhealthy states, rather than to those of the rest of the digestive tube.

SECTION F.—*The Muscles of the Alimentary Canal.*

The œsophagus is a transition from voluntary to involuntary muscles; the upper part consisting of the striped fibres of the former kind, the lower part of unstriped fibres of the same sort as in the muscular layer of the bowels. We know also very well by personal observation, that we can in some degree control the motions of the commencement of the gullet, but by no means the succeeding ones. In animals the voluntary fibres are formed much lower down, probably to enable some of them to exercise the voluntary function of chewing the cud, and some to throw up, by a more voluntary effort than we can, any unwisely-swallowed substance. The inner thin layer of muscle runs round and round the canal, so as to create some degree of peristaltic wave, but the chief coercive agents are the bundles of strong muscle which form the main bulk of the tube. Firmly, quickly, and steadily by these is the morsel pressed down.*

When the food gets to the stomach it finds everything prepared for its remaining there a considerable time. To pass from a narrow into a wider area diminishes velocity of motion, and the motion is still further arrested by the universal weakness of the gastric muscles in comparison to those to which the mass had previously been subjected. The fundus of the stomach especially, where the food first arrives, is weaker than the rest, the thickness of the muscular coat at that part varying from a third to a quarter of its measurement near the pylorus.

In the stomach commences in earnest the peristaltic or rotatory motion of the circular fibres. In the œsophagus it had been quite kept in the back-ground by the longitudinal pressure, but here it must be principally relied on. The regularity of its churning movement, by which it unites into a smooth mass the food and drink and secretions in the stomach, is immortalized by Dr. Beaumont's description of it, as seen in Alexis St. Martin. The spare longitudinal fibres continued from the œsophagus, principally along the smaller curvature to the pylorus, have only a very gentle propulsive power on the great collection they have to work upon.

After the pylorus, the muscular layer gets thinner again, and keeps getting gradually thinner as we proceed lower down. The longitudinal fibres are more and more scattered, and have therefore less and less power; so that regulated detention is evidently the characteristic pointed at by nature in this part of the bowels. Still, as the area is narrowed, the motion is quicker than in the previous receptacle of the aliments.

In the colon the peristaltic motion is not required to be so active. This gut is again a sort of cistern, and concentrates the remains, and keeps them till it is convenient that they should be voided. So the circular fibres are here much thinner. The longitudinal fibres are collected into three strong bands, whose action may be supposed to be that of shortening and stiffening the intestines so as to press the fæces, especially the solid fæces, onwards into the sigmoid flexure. Here the three bands are united into a continuous layer, which gets still thicker, till in the rectum it has returned to the same measure which it exhibited in the œsophagus, that is, about a line in depth. There are not however here, as in the gullet, any striated fibres,* but the voluntary department is executed by the internal and external sphincters and the levator ani muscles. The business of the rectum is purely to make excretion convenient.

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* Kölliker, *Microscop. Anatomie*, vol. ii., p. 126.

Of the parts above named, the mouth and œsophagus possess sufficient common sensation for their mode of action to be necessarily familiar to us all. We are sensible that in the gullet the morsels of victuals are passed downwards by a dilatation of the tube in front and a continuous contraction behind them. But when we come to the stomach and intestines, I doubt whether the peristaltic action is quite so generally appreciated. The circular contraction of the circular fibres, and the longitudinal contraction of the longitudinal fibres of the muscular coat of the alimentary canal, is indeed easily assumed, but it is not easy to conceive a general notion of the whole, or how it helps forward the contents of the tube. As we view it in the bowels of an animal just felled in the slaughter-house, it is too tumultuous to convey a distinct idea of its normal course to the mind, and indeed seems just as likely to press the alimentary mass backwards as forwards.

The peristaltic motion is, in fact, a wave, moving indeed a great deal quicker than the moistened solids which it propels onwards, but still causing them to follow its direction as it moves circularly round and round the tube, or spirally forwards.

The most beautiful example of motion communicated by the mechanism of a muscular wave over a flat surface, is to be seen in the feet of the common univalve water snails. On a fine day they are often to be found floating feet upwards on the surface of the water, and then the way in which the flat surface acts in propelling the weight of the body and shell may be perceived in action. Two waves meeting at an acute angle in the median line, keep passing from stem to stern of the foot, and even in this disadvantageous state of balance, with scarcely any resistance in the aerial surface they are in a manner walking upon, they move about slowly. On a hard substance they of course move at the natural rate, but the wave cannot be seen.

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* Kölliker, *Microscop. Anat.*, vol. ii., p. 185.

As the wave of the foot propels the moveable body of the snail over the fixed surface, so the peristaltic wave of the alimentary tube, itself being fixed, propels forward the moveable mass which lies in contact with it. This simple example conveys a better notion to the mind, than any elaborate mathematical explanation.

By this circular wave, while the whole mass is rotated, the external softened portions are continuously swept onwards, being separated and moved forward by the wave moving quicker than the mass. Thus it is always being diminished in its progress along the alimentary canal, till the whole is turned into an homogeneous liquid chyme.

It may be remarked that the peristaltic is a *regulating* movement. By forcing them to go round and round, it arrests the too rapid onward passage of fluids as much as it hastens the solids, and so keeps the food and secretions together. It thus opposes itself to gravitation, which would cause the weighty liquid food to go on much quicker than the light solids; as is shown in the œsophagus, in which drink descends much easier than meat. The importance of this regulation of rapidity in the stomach and intestines must be very considerable.

It is obvious that the peristaltic act, being due, as all muscular motion is, to nervous influence, must be affected by all things that affect the latter. Whatever withdraws the energy of the sympathetic system in other directions, probably diminishes its activity here, or whatever paralyses it altogether, weakens it here in common with the rest of the animal body. Hence strong emotions, though they increase the action of the heart, and distort with involuntary contractions the facial and other muscles, on the other hand arrest the movements of the stomach, and cause the last eaten meal to remain motionless till the excitement be passed over. A similar effect, though in a minor degree, is produced by voluntary exertion, perhaps in consequence of the connexion of the sympathetic and cerebral systems; or it may be because the nervous energy, whatever its essence may be, is of the same nature for both systems and obedient to the same laws.

That the connexion of the cerebral and sympathetic systems is not essential to peristaltic motion, is evidenced by some experiments before quoted of Drs. Bidder and Schmidt, in which the vagus nerve which unites the two was divided in the neck. It suffices to notice here that the movements of the stomach did not at all cease in consequence of such division, though the observations made were protracted for several days; while the gullet showed the dependence of its motions on the cerebrum by becoming quite paralysed. These facts would induce one to attribute the torpor of the intestinal canal which follows bodily exertion, &c., rather to the exhaustion of something which is a common element in the action of both voluntary and involuntary motion, than to the deficiency of its supply from the former to the latter.

SECTION G.—*The Media of Solution.*

There is annually at Oxford a sermon preached in the vulgar tongue, with the special design of warning those who a few days before have received the higher degrees of the University, against pride in human learning. Few of those present can forget the advantage taken of this anniversary—technically called "Humility Sunday"—by Bishop Wilberforce, when the British Association happened at that time to be holding their meeting on the banks of the Isis. If present intentions are to be realized, and Oxford made a *bona fide* school of physical as well as mental science, such a sermon might be profitably replaced by a review of the attempts made to connect the chemical analysis of the animal juices with their physiological action. If educated persons in general knew the amount of untiring energy strong will and zealous hope which have been expended by minds of greater than ordinary calibre in endeavouring to unravel this knot, which all the time is probably as simple as the law of attraction, or any other great natural law, they would be in no danger of being "puffed up by knowledge" of the human intellect.

The weakness of man's powers is more strikingly shown in

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this branch of learning than any other, because from the earliest times it has attracted the attention of all investigators of nature and appliers of science; and the further we go back the more positive is the profession of knowledge on points concerning which ignorance is now confessed. So convinced were the chymiatric school of Paracelsus of the value of their "fermentation theory," that they transferred it from the process of digestion to explain the whole circuit of life, normal and morbid. We have been witnesses of a somewhat more modest attempt in our own day. Though romance has faded and zeal cooled, we still see such an amount of energy employed in carrying out to its extreme consequences each proposed idea, as may guarantee that the full interest of many minds is exerted upon it. Yet the result is that not only is the theory wanting, but that the facts which are to be the groundwork of it seem less and less firmly established. That which to-day seems fixed by the most irrefragable experiment, is to-morrow rendered doubtful by equally clear observations. Penelope's fingers are completely outdone. Well indeed may Dr. Lehmann remark, that such experience should, more than any other, admonish us to be reserved in our judgment upon those results of researches which appear even absolutely certain.* Might not the existence of lactic acid in the gastric juice have been so characterized? Yet has Professor Schmidt "shown" (as chemists say) its absence under many circumstances, and the presence of free hydrochloric; while we see M. Blondlot coming back again to his former belief in the acid phosphate of lime, though the incorrectness of this has been asserted by the best chemists of the day. Who would have expected, after Dr. Bernard's recent experiments on the resolution of fat into fatty acids and glycerine under the influence of pancreatic juice, that German physiologists would hardly allow that secretion an emulsive power? The presence of sulphocyanide of potassium in the saliva alone of known natural substances, has been long ascertained, and it is more abundant in proportion to the vigour and health of the individual, yet the use of this singular and unique substance is utterly unknown. In despair,

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* *Physiolog. Chemie*, vol. iii., p. 261.

Dr. Kletzinsky suggests that it is to prevent our mouths from getting mouldy! while the real physiological actions of the saliva do not appear to be promoted in the slightest degree by any ascertainable ingredient.

In default of real analysis, chemists dry some of the albuminous organic juices, such as saliva and gastric juice, and call them when dried "ptyalin," or "salivary disastase," and "pepsin." But that seems to be merely giving another name to a fluid rendered rather more permanent by having its water partially removed.

The meeting, then, of analytical chemistry and physiology on this ground is prevented by a great gulf; they have not as yet acted on one another. That it will at some future time be bridged over, may fairly be expected; but at present there is not much in the analysis of the organic fluids germane to physiological reflections, and truth agrees with etymology in not deriving chemistry from the χυμοὶ, or "juices," as some have done. The analyses of the digestive fluids with which works on physiology are interspersed, contribute, it will be observed, scarcely at all to the main argument, and are obviously more ornamental to it than useful. The science of life is still, for example, only in a position to view the secretion from the mouth as "saliva," though we see it to be different from different localities of the cavity, and the secretion from the variously constituted portions of the stomach as "gastric juice;" and though these, and the "bile," and the "pancreatic juice," &c., easily separate into several parts to which names may be given, we have not yet learned the properties of those parts; indeed, we are not quite certain which are educts and which are products of our manipulation. In the following pages, therefore, the saliva, the gastric and pancreatic fluids, the secretions of the liver and that of the intestinal membrane, will be treated of as simple substances, and their reactions will be viewed as *physiological*, that is, as part of the great laws which we see developed in living beings, and not yet seen to harmonize with that series of phenomena usually called *chemical.*

Though in this volume we shall generally have to consider the digestive juices as solvents, we must not forget their great importance as forming the contributions of the intestinal canal to those wonderful circulations going on through the membranes, which have been previously enlarged upon (see pp. 34—38). They are constantly pouring forth a fluid comparatively empty of matter proper for the support of animal life, which is to return shortly loaded with nutriment, and is therefore provided with means adapted to take up the different forms of that nutriment presented to it. They go out poor, and have the opportunity of returning rich, if the due instruments of collection are given them.

At the same time the *excretive* duties of the fluids of the alimentary canal must not be forgotten. When they are retained, and dispersed by the blood among the fluids and solids of the organism, they are certainly injurious by their presence where they are not wanted, as well as by their absence where they are wanted. Jaundice is the most striking instance of this; the malaise of costiveness is another. So much of the colouring matter of the bile is found in the fæces, and so much of the triple phosphate of ammonia and magnesia, that it seems clear these matters are rejected as no longer required, by means of the liver and the mucous membranes. We may conjecture, too, that even some of the solvents which in union with aliments re-enter the organism, are, *when they are sent out*, excrementitious, and that they are not fitted to return without the matters they are designed to dissolve. Such would seem to be the interpretation of the copious stools or even diarrhœa of starvation; and perhaps the actions of some purgatives may be partly elucidated on this principle.

CHAPTER III.

THE MOUTH AND GULLET.

THE most prominent properties of mucous membrane as an instrument of absorption, have hitherto been reviewed in a portion of that membrane, taken as an illustration, where the properties are exhibited in a less degree probably than in any other situation. My object in taking this course was to lead the reader, by the convenience of the reference, to think over these matters frequently and habitually, and to induce him to draw his mental pictures of Nature's doings from healthy life. The illustration will be returned to; but first, it is necessary to go through the intestinal canal, and point out the differences, in respect of the performance of the required duty, which different portions show; and also, to mention some additional structures playing a considerable part therein, which can scarce be said to exist at all in the mouth.

I.—*The Epithelium.*

The same sort of scaly *epithelium* that lines the mouth and fauces is continued down the œsophagus. We subject it to all sorts of hard usage by a variety of things that we swallow consciously and unconsciously—fiery drinks, acids, alkalies, hot tea, ice, grating crusts, scraping bones, and lumps of all sizes and shapes, as a general rule, and exceptionally jugglers' swords, clasp knives, halfpence, &c. So that the epithelium needs to be pretty stout to pave the road for such passengers; and it covers the papillæ completely, filling up their interstices, but still allowing liquids freely to pass through its pavement* scales to them.

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* The phrase was classical before it was scientific, being rendered so by the well-known exclamation of Lord Duberly in *The Heir at Law;* "Madam, my throat ain't *paved.*"

The tongue may be viewed as an exaggeration, one might almost say a caricature, of most of the qualities of mucous membrane. Among others, the power of forming epithelium is there exhibited in a magnified condition. You can scrape off thick masses of it in an effete state. And when anything disarranges the secreting force of the intestinal mucous membrane in general, even when it is so slight that it probably could not be recognised without a microscope, we have fair notice of it in the appearance of the tongue. There used to be, and still is, a good deal of nonsense talked about a mysterious sort of affection or sympathy felt by the tongue for the disorders of various parts of the body. The word "sympathy," if used in any but a loose and metaphorical sense, is a mere shield for ignorance. If a vague notion is intended to be conveyed, by all means let a vague word be employed, but let it not be supposed that it explains anything. To take one sort of tongue as an index of disease of the liver, another as showing a watery state of blood, another inflammation of the lungs, and so on, though it may be sometimes true in individual cases, leads to great faults in practice, and complicates what is in reality a very simple affair. The surface of the tongue is, in respect of its epithelium and papillæ, neither more nor less than a very exaggerated piece of mucous membrane; and as is usual in exaggerated things, the proportions and shape of the parts are somewhat altered. Hence, when anything deranges the whole intestinal mucous membrane, sometimes perhaps alone, but usually in conjunction with all the rest of the system, the derangement is seen exhibited in full force in this locality. If the epithelium is formed in too great quantity, and is so sticky that it is not wiped away as usual, we have "coated" tongues of various colours. If at the same time it is tough and adherent like a skin, it then retains the shape of the thread-like papillæ, and projects from their ends, lengthening them so as, instead of a pile like velvet, to form regular hairs like a fur—the tongue is said to be "furred." But if it is less tough, it merely fills up the interstices between the papillæ, and is called a smooth "creamy" tongue. If there is a too rapid throwing off of epithelium, or if it is not formed in sufficient quantity, the tongue is bare, and is seen to be red or "raw." If there is a want of red blood in the mucous membranes, the natural elasticity and swelling are deficient here in a marked degree, and we have what is denominated a "pasty" tongue, taking the marks of the teeth. And thus are formed a variety of appearances, named and unnamed, which it is a great part of a successful physician's practice to recognise. In fact, without the tongue, I do not know how we should ever find out the state of the internal canals. More grrtitude therefore would be due from medical men to physiologists, chemists, and other men of pure science, who would turn their attention in this direction, than to the investigation of perhaps any subject in the domain of experiment.

The remarkable cohesive power possessed by the epithelium of the tongue in cases of "furry coat" much developed, is well shown by some woodcuts in the *Cyclopædia of Anatomy and Physiology*, where the scales are seen sticking so tightly together as to form long threads rough and scaly like the filaments of wool; so that one could easily imagine their being matted together and felting, if dried. Indeed, so strong and permanent are these projections of epithelium, that they are retained long enough in some cases to become mouldy. The seeds of the peculiar mould which grows there, are, it may be presumed, drawn in with the breath, and adhere to the first part suitable to their development. They form a thick, granular layer, from which, as a base, sprout filaments of extreme fineness, but tough enough not to be wiped away by the ordinary motion of the mouth, when that is rendered languid by depressing illness. This mould is not difficult to find after death, and is described by Dr. Höfle as existing during life. It is figured in Professor Kölliker's *Microscopical Anatomy*, and in Dr. Wedl's *Pathological Histology*. In the latter it is shown also as occurring among the brown, dirty mucus which is deposited from the saliva in the parched mouth,—the "sordes" of the teeth. In which case it is mixed with a still more perfectly developed mould. The interest of it consists in the proof afforded that the analogy of nature is carried out everywhere, and that organic substances in a state of uselessness, wherever they are, become the seat of new life of another sort from what they before possessed.*

II.—*The Bloodvessels.*

The view taken of the back of the tongue as an exaggerated mucous membrane, is carried out by the form of its papillæ. So determined are they to be as long as possible, that to call them nipples is rather a misnomer, especially in the case of the thread-like ones—the *filiform papillæ.* Then again, the more stumpy sort are still so violently papillary, that they break out into little secondary papillæ all over.

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* *Cyclopædia of Anatomy and Physiology*, Article, "Tongue." Vol. iv. figg. 756, 758, 764. Höfle's *Chemie und Mikroscop am Krankenbette*, s. 59. Kölliker's *Mikros. Anat.*, ii., figg. 177, 178. Wedl's *Pathol. Histol.*, figg. 177, 178.

The representation of the *fungi from papillæ,* given in Todd and Bowman's *Physiology,* is so expressive, that it has been copied exactly by the writers who have figured the same things since—Dr. Salter and Professor Kölliker. There appears from it to be a separate loop of artery and vein for each secondary papilla.*

Whatever other objects this arrangement may serve (and in the tongue certainly it is very convenient for containing the terminations of the nerves), it has the effect, without doubt, of exposing a great surface of blood. What purpose is served by this intention being so developed in the tongue above all parts, is not clear; but as other properties of mucous membrane are exaggerated there, so is this one of spreading abroad the blood exaggerated also. The tongue is a caricatured papillary surface.

Even in the œsophagus, through which the substances to be absorbed make such a rapid transit, provisions for assisting the work of absorption are not neglected; the bloodvessels are multiplied in number and extent by means of the papillary arrangement, just as they are in the external skin and mouth. Even the shortest opportunity for absorption is not lost.

III.—*The Glands.*

The *glands* in the mouth and gullet are very numerous, and the quantity of fluid poured out very copious, much more indeed than can at all be equalled by that absorbed into the circulation in that situation; so that there is great excess poured along the surface of the membrane downwards. The water thus secreted over and above that imbibed, amounts, as deduced from the joint calculations and experiments above detailed, to three or four pints a day (see page 35). The reason for this we shall see when we come to consider the preparation of substances for absorption; but it must be noticed that here we are concerned with secretion only as a preliminary stage of "absorption" in its narrow sense, as a part of the great circulation of water.

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* *Cyclopædia of Anat. and Phys.*, Article, "Tongue," fig. 755. Kölliker, *Mikros. Anat.*, fig. 174.

Mixed with the water are a variety of matters, some of which are peculiar to particular parts, and others are in different proportions. The most remarkable of the former is *cyanide of potassium*, which occurs nowhere else in the body, and whose use is entirely unknown. It is, however, by no means an accidental or morbid product. It has been found under all circumstances, and according to Dr. Wright, is increased in quantity by the same things which increase the saliva generally—viz., local stimuli.

Of the matters which are found in varying proportions, the mucous globules and epithelial scales are instances. If you carefully allow the dew-drops to ooze from your under lip, you will find them quite transparent, and showing under the microscope only an occasional globule and scale. While, if you take some of the fluid from the tonsils or from the back part of the tongue, it is much more opaque and white, and exhibits a mass of shed epithelium of all stages of growth.

To furnish these two sorts of secretion, there are in the mouth two sorts of glands, differing considerably in their intimate structure—viz., the arborescent or branched glands, and the follicular. It is difficult to convey a just notion of the formation of such parts without the expense of engravings, but the first may be roughly compared to a bunch of grapes, with the stalks and fruit all hollow, and the other to one or several fingers of a glove with solid grapes stuck all round about them. The ultimate structure in the first is an intricately branched tube, with the branches opening into a common duct: in the last it appears to be a number of small round bodies, which lie under the epithelium lining the bag (or glove fingers), but not opening by any mouth to the external surface. The *arborescent* glands are branched hollows in she mucous membrane; the *follicular* glands are hollows in the mucous membrane, surrounded by closed sacs or capsules. In the *arborescent*, the papillæ cease at the opening of the duct, and the bloodvessels form a common network around the subdivisions of the tube; while the epithelium continues indeed to form the lining of the ducts as it has of the papillæ outside, but is somewhat changed in kind and arrangement. It is very thin and delicate, and is in truth so difficult of detection that it is likely to be seen only by those whose occupation is specially directed to microscopic anatomy. *We* must probably be content to take it on faith in Professor Kölliker's correctness of observation. It is formed, according to him, of a single layer of polygonal scales or cells, united by their edges so as to form a membrane.

The *follicular* glands, in their simplest form, consist of a bay-like depression in the mucous membrane, into which both papillæ and epithelium seem to dip and line the hollow throughout, much in the same form as they do the external surface. The more compound or conglomerate form consists of a number of these opening into common passages. In both cases, beneath the epithelium and papillæ lies a thick wall, containing, or formed of, a number of rounded capsules, without any outlet—closed sacs enclosing a whitish-grey granular mass. Amongst these capsules and around their walls ramify the bloodvessels.

In the class of *arborescent glands* are to be counted, first those "labial" glands which we were a short way back describing on the under lip as illustrative of the mucous membrane as a fountain of water; then a number of similar ones, called, after their situation, "buccal," "palatine," and "lingual." But the most important in point of size are the "salivary" glands. The smallest of these, the "sub-lingual," in spite of its insignificant size, forms enough secretion to squirt it out in a minute *jet d'eau* when we open our mouth and turn up the tongue before a mirror. The parotids and submaxillary would divide into more than a dozen of it, and may be supposed, therefore, to supply fluid in proportionate copiousness: but their energy cannot so conveniently be exhibited, for you cannot compress them by muscular contraction as you can the sub-lingual.

Among the arborescent glands, also, are to be included a moderate amount of small glands which lie under the mucous membrane of the œsophagus, much resembling those of the under lip which we can see during life, and from one-sixth to half a line in diameter. At the lower end of the gullet they are a good deal larger, about two lines in breadth, and form what are called the "cardiac" glands. According to Professor Kölliker, there is no structural difference at all between these and the glands of the mouth above described.

The *follicular glands* are those at the base of the tongue, which extend from the last papillæ backwards to the epiglottis, forming a continuous layer, and existing in their simplest shape. Continuous with these, on each side are the more compound forms of the follicular glands, so well known as the "tonsils."

The difference in the secretion of the two sorts of glands found in the mouth has been before alluded to, and will again come under more particular review when we are considering the changes effected on articles of food by these fluids in the preparation of them for absorption. It need here be only remarked that, according to the anatomist above quoted, it is the branched glands alone which secrete the transparent fluid, and the follicular alone which secretes that before described as thick, white, and filled with shed epithelium.*

But after having spoken of the glands as the chief sources of the water that is poured into the mouth, we must not forget that mere exhalation from the surface of fluid transuding through the walls of the vessels must supply a considerable quantity. We see how very large this exit for water is in the case of the lungs; and though, of course, from the higher degree of saturation of the contents of the intestinal canal it is less there, still it should not be entirely passed over. Even in the mouth, where the thickness of the epithelium must be an additional impediment, it must still be of some importance.

As a whole, then, the mouth and gullet may be described as a locality distinguished by but slight absorption and great secretion—as making it their chief business to send outwards from the body the chain of the watery circulation, and drawing it back very little—as great manufacturers and exporters, and small importers or consumers. It will appear, too, in a future page, that what they do import are principally articles of luxury and superfluity, rather than absolute necessaries; while what they export is of the highest importance in promoting absorption in other parts.

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* For the minute anatomy, see Kölliker's *Mikroscop. Anatomie*, buch v. (principally).

IV.—*The Saliva.*

The known functions of this fluid in the preparation of substances to undergo absorption, are confined to two, viz., the SOLUTION OR DILUTION OF MATTERS SOLUBLE IN WATER, and the CONVERSION OF STARCH INTO SUGAR.

A.—*The Saliva as a watery fluid—its quantity, &c.*

Solution in water is a duty which it performs, in common, indeed, with all the other digestive fluids, yet is it in a striking manner distinguished, in mammalia at least, by being the first to commence it, and by having a special apparatus provided in the teeth and jaws for aiding it by mechanical means. The extent to which it acts in this respect is closely dependent on its quantity, for beyond the point of saturation with the matters submitted to it, water can have no solvent power. The amount therefore of the saliva has always presented an interest, but until lately the difficulties which surround the subject have prevented any trustworthy estimate being made. It is needless to remind the reader that it varies from minute to minute; a thought of dinner will fill the mouth with it, and continued mental attention to other subjects will dry it up for a long period; hardly any is secreted during sleep, but on waking it immediately begins to flow. Again, the nature of the food causes the quantity furnished during meals to vary exceedingly, hard dry meats exciting a much greater flow than those which are moist and soft, even though no special salivary stimulants, such as spices, are used. Nay, even the motion of the under-jaw in speaking or singing causes an increased secretion. It is clear, therefore, that the amount obtained in a short fixed time is no test of the whole activity of the glands—it is not sufficient to multiply by 96 that which runs from the mouth in a quarter of an hour, in order to know the daily supply. While at the same time so difficult is it to prevent the swallowing of some as it forms, that such a mode of estimation alone is worth but little. Hence there is usually to be found in books on physiology a list of distinguished names, who vary very much in the estimate they give of the amount; the variation being dependent on the different modes they have adopted to arrive at the result.

The most trustworthy series of experiments made with a view of settling this question, appear to be those of Drs. Bidder and Schmidt. They took a dog, weighing a little over thirty-five pounds (sixteen kilogrammes), and making separate fistulous openings from the outside into one of the Whartonian ducts of the submaxillary gland, and one of the Stenonian ducts of the parotid, collected the fluids which came from each. The first yielded in an hour 86 grains (5·640 grammes), the latter 135½ grains (8·790 grammes) of saliva; so that the two submaxillaries and the two parotids may be reckoned to be capable of forming by the hour 222 grains.

Taking the average weight of a man to be four times that of this dog, namely about ten stone, and reckoning that as his salivary glands bear about the same proportion to his size as in the canine race, and that his food is not dissimilar in nature, the experiment which applies to one would apply to the other, they estimate his possible hourly secretion at quadruple the above figures,—viz. 888 grains. But as the circumstances under which the animal was obliged to be kept increased the secretion unnaturally, and as the flow during sleep is arrested, they think that it would be fair to multiply it by twelve only instead of by twenty-four, for the daily amount. This brings it to three pounds as an average, rough indeed, but as near the truth probably as the means enable us to arrive.

In order in some degree to test the accuracy of this estimate, the experimenters tried to observe on themselves how much saliva was formed in their own mouths in an hour, taking care to swallow none, but using no artificial stimulus, and spitting it out as secreted. The quantity was from 1543 to 1852 grains, (100 to 120 grammes), which deducting seven hours as spent in sleep, would amount to from three to four pounds a-day; a close approximation to the estimate made in the previous way.

The quantity of saliva poured out is very variable at different times. It alters not only in obedience to the well-known mental influences, but according to the nature of the food. Some experiments are recorded by Dr. Bernard in the *Archives Générales de Médecine* for 1847, in which the gullets of horses were opened, and the food swallowed was intercepted for observation. It was found that straw and hay were mixed with four or five times their weight of saliva; whilst starchy seeds, such as oats, received only their own weight, or perhaps half as much more, green fodder only half its weight, and watery aliments scarce any at all.*

On the other hand the diminution of the discharge during rest is shown by the observation of Dr. Mitscherlich on an Israelite patient with a salivary fistula, from whom, after long abstinence on fast days, or perfect quiet, and during the night, scarce a trace of fluid escaped. It must be observed, however, that this individual was a weak emaciated subject on low hospital diet, and so little excitable that even smoking tobacco produced but little secretion of saliva, and it must not therefore be supposed that in the healthy condition the same complete cessation occurs.†

It is also familiar to all of us how certain spices and acids increase the secretion ; as also mechanical violence, such as picking the teeth or the manipulations of a dentist.

Connected with the action of stimuli, it is a remark of much importance, that the effect lasts not only during the presence of that which excited it, but for some time afterwards. It is not only during the chewing of the meat that our mouth waters, but great quantities of fluid continue to be swallowed for a considerable period after a meal. And it is the same with more artificial stimuli also: for instance, that false thirst arising from great evaporation and dryness of the fauces in mountain excursions is relieved, not only momentarily but for a long period, by a pipe of tobacco. Such a continuance of the flow of saliva shows that it is supplied not merely for the purpose of moistening the morsel and so enabling it to be swallowed easier, but to assist in its future solution in the stomach.

I suppose no one ever doubted the necessity for this moistening of the morsel chewed. If he does, let him only climb Snowdon or the Rigi under a hot sun, and when his mouth is parched, try to lunch on a slice of bread, nay, even something moister, a piece of fresh meat, to the amusement of his companions.

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* *Arch. Gén. de Méd.* (quatrième série) xiii., p. 22.

† *Ueber der Speichel*, von Dr. C. G. Mitscherlich, p. 9.

Great as are the variations in the *quantity* of saliva arising in the same individual from different circumstances, the *quality* seems to be unaffected. It is remarked by Drs. Bidder and Schmidt, that whether secreted quickly or slowly, it always presented the same appearance; both to the naked eye and the microscope, when collected from the salivary glands.

There is however a very considerable difference between the different sorts of glands in regard of the amount of water their products contain. So aqueous is that from the parotids, that Drs. Bidder and Schmidt agree with Dr. Bernard in thinking that their use is confined to this production—that they are *glandes aquipares* only. In an analysis by Mr. Jacubowitsch, made in their laboratory at Derpt, there were found but 4·7 parts of solid matter in 1000 in the parotid secretion, while the mixed saliva of all the glands, together with the buccal mucus, contained 10·37 parts. The parotids then would appear, from our present knowledge, to belong wholly to the portion of the subject we are upon now, and to supply water for the great chain of the intestinal circulation of diffusion, which water acts immediately as a solvent on those articles which it is capable of dissolving. The secretions from the other glands in the mouth belong, in a great measure, also to this department of physiological duties, but to them we are enabled (by the researches of the above-named experimenters most especially) to assign another and perhaps still more important action, which will now form a subject for consideration.

The Conversion of Starch into Sugar.

The formation of sugar out of amylaceous food is not indeed a newly discovered function of the saliva, but so much light has been thrown upon the circumstances under which it takes place by the well-directed industry of the Derpt laboratory, that the results there obtained may fairly be taken as the text to which the researches of others may be appended as a commentary.

If a fresh pap made with pure starch be chewed in the mouth for a short time, a decided sweet taste will witness to the experimenter's sensations the change we are now considering. But it does not show the remarkable fact of the *almost instantaneous* nature of action. If a decoction of starch, proved by Trommer's test to be free from sugar, be mixed with an equal quantity of fresh saliva, and shaken up at the ordinary temperature of the room, the stringy mass immediately undergoes a remarkable alteration: that is to say, from being gelatinous it becomes thin and watery. If examined with iodine, the starch will be found to have disappeared; if Trommer's test be applied, the reduction of the oxide of copper and a brilliant brick-dust sediment give indubitable proof of the formation of sugar.

Dr. Bidder remarks, "The *instantaneous* commencement of this action is especially to be noticed in deciding whether other fluids of the animal body possess similar properties, or whether this is an exclusive peculiarity of the saliva. We shall have occasion presently to point out that the pancreatic and intestinal juices agree exactly with the saliva in this respect. But if the same peculiarities are ascribed to many other organic substances, such as nasal mucus, the tissue of the kidney, putrid blood, and so on, and experiments are appealed to in which such substances mixed with starch cause its conversion in eight or a dozen hours, at the temperature of 104° Fahr. (as is done by Frerichs in his article on 'Digestion,' in Wagner's *Physiological Dictionary*), we must decidedly object to the application of such experiments to the point in question. For even fresh boiled starch at such a heat, left to itself, will undergo spontaneous decomposition, and often, nay generally, traces at least and even decided quantities of sugar may be recognised in it. It is only when after a short time the conversion into sugar has taken place in an indubitable manner, that it can be ascribed not to a spontaneous change, but to the action of the peculiar fluid and the temperature. There are however several animal substances which have the power of occasioning the appearance of sugar in a decoction of starch in so short a time as to exclude the suspicion of spontaneous decomposition. But even in these cases there is required a period of time quite out of proportion to that in which the saliva effects the change."

He calls attention also to the fact in respect of the nasal mucus, that it is difficult to obtain proof that the specimen used has no saliva in it; for in sneezing, coughing, &c., it is constantly driven into the nostrils, and that in many of his experiments the action did not commence for a quarter of an hour.

If then we include the pancreas among the salivary glands, the conclusion can scarcely be avoided that their secretion is κατ' ἐξοχῆν the converter of starch into sugar.

In the following table are arranged the results of a number of experiments made by Drs. Bidder and Schmidt for the purpose of testing the time occupied by the conversion of starch under the influence of various secretions from the living animal and different parts of organs taken from recently killed beasts.

Substances mixed with boiled starch paste.*	Time within which the formation of sugar began.
1. Saliva of adult man	The formation of sugar began instantaneously, but only in No. 1 was all the starch so changed that iodine induced no blue colour; in the other experiments the whole starch was decomposed in various periods, the longest of which was an hour.
2. Nasal mucus of ditto	
3. Saliva of child four months old	
4. Saliva of dog	
5. Pancreatic juice of ditto	
6. Pancreas of ditto	
7. Parotid of full-grown pig	
8. Pancreas of ditto	
9. Gastric juice of dog rendered neutral by swallowing the saliva copiously	
10. Mucous from the urinary bladder of pig	½ an hour.
11. Saliva of dog, the parotid secretion being cut off	20 minutes.
12. Pancreas of a puppy ten days old	40 minutes.
13. Submaxillary gland of full-grown pig	1 hour.
14. Liver of ditto	1 hour and ⅓.
15. Muscular coat of bladder of ditto	1 hour and ½.
16. Acid gastric juice of dog in which there were no epithelial cells from the mucous membrane of mouth	1 hour and ½.
17. Submaxillary gland of puppy ten days old	2 hours and ¼.
18. Parotid of ditto	3 hours.

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* *Raw* starch is not affected by the saliva, nor indeed by any of the digestive juices. It may be found with the envelope unbroken in the fæces.

Substances mixed with boiled starch paste.	Time within which the formation of sugar began.
19. Mucus from the mouth of dog, where the salivary ducts had been tied a fortnight previously	After 3 or 4 hours evidences of sugar appeared, but the starch paste remained viscid and thick.
20. Watery extract of mucous membrane from mouth of ditto	
21. Parotid of ditto	
22. Submaxillary gland of ditto	
23. Parotid secretion of dog	After 8 hours traces of sugar appeared.
24. Submaxillary secretion of ditto	
25. Orbital gland secretion of ditto	After 7 hours no sugar.
26. Saliva with the exception of the submaxillary secretion	None after 2 hours.
27. Acid gastric juice of a dog where all four salivary ducts had been tied	None after 15 hours.

Dr. Lehmann remarks that if the word "instantaneously" be allowed a little license of signification, his observations are quite in accord with those above quoted.*

That the various secretions which enter into the composition of the saliva have not all the same nature and office has been already mentioned. The parotids, the submaxillaries, and the buccal mucous membrane hold different ranks as water-bearing organs, though in truth all may come under that designation more or less. But in the conversion of starch into sugar the same does not hold good. It is not the property of all to effect this change more or less, or even for one to effect it and the other not, but they require a certain admixture with one another for the due performance of their duties. Drs. Bidder and Schmidt obtained separately not only the pure secretions of the glands in question, but also that from the buccal mucous membrane of the dog, as also the parotid secretion of the ox. These fluids were each separately mixed with starch paste, at a temperature of 104° Fahr. In no case was sugar detected before eight hours by Trommer's test, and then only a trace. So that they conclude absolutely, in accordance with an opinion previously published by Dr. Jacubowitsch, that *to none of the secretions, which by their union constitute saliva, can the power be at-*

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* Bidder and Schmidt, *Die Verdauungssäfte*, 17. Lehmann's *Phys. Chemie*, iii. 292.

tributed of being able alone to convert starch into sugar, but only to a certain admixture of them together.

The next question is the mutual relation which the secretions have to one another in the composition of this mixture—that is to say, are all these required? and if only two, which two?

All are *not* required; for in the experiments of both Drs. Bidder, Schmidt, and Jacubowitsch, buccal mucus and submaxillary fluid effected the purpose.

Whether buccal mucus and parotid fluid will do is undetermined, for the experiments do not agree.

Parotid and submaxillary secretion mixed are insufficient, even after many hours.

The power, then, of fermenting starch into sugar resides in the *buccal mucus mixed with the submaxillary fluid.*

Where does the ferment reside? Is it a fluid dissolved, or a solid floating in the saliva? The latter is improbable, for otherwise it surely would be found in one or other of the secretions. Besides this, it was found that the removal of all visible particles by filtering did not diminish the converting power; nor indeed did even the precipitation of the mucus by alcohol. It is therefore a fluid, and to chemistry we must look for its future isolation.

Some interesting observations were made by Drs. Bidder and Schmidt, on the condition of the saliva during that period of life when food devoid of starch is naturally supplied to the animal, and none containing it is taken, and when therefore this converting power is not required. They found—

1. That when fistulous openings were made into the Stenonian ducts of young calves, no fluid escaped, and their buccal mucous membrane is devoid of action on starch.

2. Starch was converted into sugar immediately by portions of salivary glands of full grown animals, as exhibited in the above table. But if portions were taken from those only a few days old, it was several hours before the change took place; so that in fact they acted no quicker than any other animal tissue.

3. When a thick decoction of starch is mixed with an equal portion of the saliva of an adult man, it is not only immediately, but completely converted; when mixed with that of a

baby five months old, the conversion began indeed immediately, but was not completed for an hour.

4. Very young children, that is to say during the first few days of life, secrete no saliva from the glands. It is not till a later period that they become proverbial for their brimming lips.

Few more interesting evidences of design in the constitution of Nature can be found than this absence of the power of assimilating a peculiar aliment at a period when a more perfect nutriment is naturally supplied, and its acquisition as soon as, or sooner than it is required to be exercised.

Such observations, too, are essentially practical, as teaching us a reverent imitation of Nature when we are compelled to supply its place, by warning us not to starve our infants by cramming them with food which they have no means of digesting, which must act as foreign matter in the bowels, and prevent the digestion of proper nutriment. One's wonder is excited at the extreme hardihood of the human race, when we see babies survive the arrow-roots, the sagos, the revalenta arabica, the &c. &c. with which they are dosed.

The experiments above detailed relate, as may be noticed, only to the effects of saliva separated from the body, and the questions remain, whether *within* the body circumstances do not arise to modify the action? and in what part of the digestive canal the metamorphosis is carried on? In fact, proof is wanted that the change of starch into sugar commenced in the mouth is continued in the stomach. The food is retained in the mouth not sufficiently long for enough saliva to be secreted during the chewing for the conversion of the whole amount of starch, so that it is a matter of some importance that it should not be limited to its short stay in that place for obtaining its saturation. And since much saliva is swallowed at other times besides during eating, it is interesting to know whether it can continue to exercise its peculiar metamorphic function or no.

An idea has prevailed that the neutralization of the alkaline secretion of the mouth by the acid gastric juice, must stop its action; and the following experiment by Dr. Jacubowitsch seems rather to confirm this impression:—saliva from a dog was mixed with an equal quantity of gastric juice obtained by an artificial gastric fistula, so as to be in one case neutral, in another strongly acid. Both mixtures, after standing for a couple of hours at a temperature of 104°, exhibited proofs of sugar by Trommer's test. Now as pure saliva causes the change to take place *immediately*, the delay of two hours may with some justice be attributed to the effect of the acid gastric juice.

Though, however, it *impedes*, it does not entirely *arrest* the conversion of the starch. We have as yet certainly no evidence against its again going on with its original rapidity, when the food has passed out of the limits of the acidifying influences of the stomach, and reached the alkaline intestines. A series of experiments would be valuable which would show whether the metamorphic action recommences on the restoration of the alkaline condition out of the body. It appears, at any rate, from those of Drs. Bidder and Schmidt, at Derpt, that the arrest is closely proportioned to the degree of acidity; and hence one may conjecture, as far as is allowable without a trial, that it is only temporary.

But in truth, even if the arrest is final for that portion of saliva submitted to it, the cessation of the secretion of gastric juice in sufficient quantities to neutralize the amount swallowed must allow the action to go on again. The stomach then is no longer acid, and consequently does not neutralize the alkaline fluid. Now this is probably the case oftener than we are in the habit of allowing for. In the oft quoted dogs with gastric fistulæ at the Derpt laboratory, the stomach was found always alkaline when the animals were deprived of food; and when fed once a day in the natural manner, they were before meals either strongly alkaline, or at least full of great lumps of frothy spittle, which of course would have acted on starch.

It is very probable that there is some difference in the power of the saliva of different animals to overcome the impediments offered by the gastric juice to the continuance of the action. Dr. Jacubowitsch's experiment above detailed, shows that the gastric juice of *dogs* delayed for two hours the activity of the saliva of dogs; but in an experiment by Drs. Bidder and Schmidt, where the gastric juice of dogs was mixed with the saliva of *men*, the starch was changed into sugar in a quarter of an hour And in an experiment performed by Dr. Schröder on a woman with gastric fistula, a solution of starch injected through the hole into the stomach after fasting, was on its return, after four or five minutes, found to contain a large quantity of sugar.* Comparing with these experiments the observations by Drs. Bidder and Schmidt thrown into a tabular form at page 65, where it appears that human saliva caused the *total* conversion of sugar, whereas canine affected it but *partially*, we may conclude that in our race gastric juice arrests much less completely than in dogs the powers of the salivary secretion, and that *by reason of the greater powers of the latter, and not necessarily any less powers resident in the former.*

I am surprised that the authors have not drawn special attention to this point, which seems a very suggestive and important one. May it not prove the great desideratum, a test of the natural food of an animal, especially of our own race? Does it not point out how the human saliva would be wasted if only nitrogenous diet were to be taken?—how clearly man is intended to eat starchy as well as fleshy food? and how, on the other hand, the dog is unsuited for living on vegetables, and fitted for meat?

The next circumstance which attracts our interest in reading the accounts of experiments on this subject, is the very curious fact, that it is a matter of controversy whether the sugar arising from metamorphosed starch is to be found in the stomach, or no. Singularly enough, Dr. Frerichs declares he has constantly found it in the filtered contents of the stomachs of men, quadrupeds, and birds of all sorts "in at least fifty experiments;" and Dr. Jacubowitsch confirms his statement; while Drs. Bidder and Schmidt, with others of older date, profess their utter inability to discover it. Errors of observation are scarce possible if it existed in any notable amount, so that perhaps the eclectic opinion is safest, that it is present in very small quantities, and sometimes absent altogether.

If sugar is indubitably formed from starch in the mouth, and yet is not found in the stomach, it is a natural question—what becomes of it? and a further demand might be made—if the action of the saliva on starch is to be arrested so soon after its commencement as the arrival of the food in the stomach, what is the use of it? Now, in the first place, a good deal of sugar may be absorbed in the mouth itself, in the gullet, and in the stomach immediately that point is reached. Then again, it may be turned into lactic acid to a considerable extent. Professor Lehmann says that after vegetable food, lactic acid is always found in indubitable amount in the stomach; and that after feeding horses with boluses of starch he has seen large quantities of lactate of lime and free lactic acid in the duodenum, and he does not know how it could get there except by the conversion indicated above. As to the suggestion, that if the action of saliva on starch is to be arrested so soon, it is hardly worth while for it to commence, and that Nature's work would be self-impeded; we must remember that though certainly it is delayed in the stomach, there is no proof that it does not recommence in the duodenum with renewed energy. Indeed, the fact that the saliva there meets with a secretion of similar character and similar powers with itself—the pancreatic juice—would alone render this solution of the difficulty a probable one.

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* *Succi Gastrici Humani vis Digestiva*, auctore E. Schröder, pag. 8, exp. 2.

In fine, the present state of our knowledge seems to render it probable, that *of boiled or disintegrated starchy food a considerable portion is turned into sugar by the saliva in its way to, and during its stay in, the stomach; but that in the stomach the conversion is delayed, to be again renewed in the duodenum:—that a good deal of the sugar formed is turned into lactic acid, and some absorbed in one form or the other.*

No other metamorphic action than those above mentioned is known or suspected in the saliva.

CHAPTER IV.

THE STOMACH.

THE stomach resembles the mouth in yielding a copious supply of water, indeed it secretes full five times as much at that place, according to a calculation before quoted (page 35). But it may reasonably be expected to differ from the previous parts of the canal in being a much more active absorber. The food remains here so long that time would be wasted if nothing was taken up from it, so that we are not surprised at the observation made by Dr. Beaumont, that fluids very rapidly disappear after their arrival here. Dr. Beaumont found on inspection of the stomach with a fistulous opening in the case of the well-known Canadian voyageur, that even in an inflamed and unhealthy state of the mucous membrane, drinks swallowed were almost immediately absorbed, though the rest of the meal remained entirely unaltered for want of gastric juice.

SECTION I.—*The Bloodvessels of the Stomach.*

This rapid absorption of liquids is easily explained by the quantity of bloodvessels which ramify on the surface. These were seen by Dr. Beaumont in the lucky opportunity above mentioned, to make the membrane of a "pale pink colour, varying in its hues according to its full or empty state." Artificial injections in museums show these bloodvessels to be a *plane* network, not prolonged into papillæ, indeed, as in the upper part of the canal, but compensating for the want of this mode of exposing a great surface of blood by the rapidity of its circulation through very large capillaries supplied by large arteries and emptied into large veins.

We read in Dr. Beaumont of its blushing bright red on the application of a stimulus, and being pale in the languid condition, and varying in every stage of digestion, so that great activity in its changes is evidently the rule.

The Glands of the Stomach.

The next observation on the stomach upon which I shall comment, is one that cannot be made without a microscope, but is so important, that it is worth the while of every one who has the opportunity to practise making it. I refer to the view to be obtained of the glandular structure of the mucous membrane by a perpendicular section.

There is no particular difficulty in obtaining this view, if you know how to set about it. Hold a piece of stomach between finger and thumb, lightly, so that the layers which form it may be distorted as little as possible from their natural position by squeezing. Then with a very sharp pair of scissors shear it off, with a flat edge just projecting above your fingers' ends. Wipe and wet your scissors, and then shave off as fine a paring as possible, and lay it on the glass. The manipulation is so easy to one at all accustomed to microscopes, that it is surprising how few people are familiar with the sight visible by a very low power,—say an object glass of thirty diameters,—and when once seen with that instrument capable afterwards of being traced even with the naked eye.

Seen thus, the section of mucous membrane looks like palisading, or a collection of short staves with rounded ends, consisting of a granular substance, all of nearly equal length, and packed quite close together, like short rolls of sand of similar size, with a very small quantity of more transparent substance between them.

Squeeze the cover glass, and the grainy substance oozes out, still slightly cohering in a mass, like the grease from the sebaceous follicles when you press the skin of the nose. But it is much softer and more easily broken up than that. You see now that instead of rolls of sand, the more correct notion of what you are looking at would be given by glove fingers filled with little round lumps of jelly. How coarse these comparisons are! we can bring them to a resemblance of Nature only by multiplying them, so as to correct one another.

These are then pipe-shaped glands, forming a secretion with a great deal of solid matter in it. And they are so numerous and close, that there is hardly room for anything else besides them and the bloodvessels between them. Of these bloodvessels there is a network at the base and a network at the outlet of the glands.

It must be the thick secretion oozing from the glands of the stomach which has made some people think that the mucous membrane here has papillæ like the tongue, bowels, &c. Dr. Beaumont speaks of seeing in the Canadian's stomach these "*papillæ* protruding through the mucous coat, from which distils a pure, limpid, colourless, slightly viscid fluid" on the application of aliments or other irritants. There is nothing in the organ at all resembling this description, except the worm-like casts from the glands, which we may assume, from Dr. Beaumont's words, he saw thrown up on the application of a stimulus.*

The different depth of the glands of the stomach makes the mucous membrane of different thickness in different parts, for the epithelium and muscular layer are of the same measurement throughout. It is thinnest at the cardia, and gradually thickens off towards the pylorus, where the glandular layer is in greatest quantity.

SECTION II.—*The Epithelium of the Stomach.*

Even in the glands, where it is closely massed together, the secretion gives the idea of containing individual globules; and if it is separately examined as it is found on the surface, these are distinct enough. They have been called "stomach cells," or "rennet cells," and have a nucleus and nucleolus. Besides this, there is a quantity of grainy matter in the secretion, which is just like the grainy matter which can be seen also in the cells, and therefore is considered to be the débris of some of these bodies broken up. If you are examining the stomach of an animal that has died while digestion was going on, you will find these "stomach cells" in considerable quantities. I have seen them in the human stomach forming a multitude of little light grey flakes, and they are described by Dr. Frerichs as constituting sometimes a continuous white layer to the naked eye. Whether they *contain* the gastric solvent or rennet, or *are* the rennet, or are the *concomitants* of the rennet, is at present a matter of opinion, but they clearly have an intimate connexion with it. We shall return to them again in their capacity of solvents; here, however, attention should be drawn to the quantity of solid matter thus added to the contents of the stomach, for in that respect the gastric juice is distinguished from the saliva, though not so remarkably as secretions we shall notice further on. Of the fourteen pounds of gastric juice daily poured out, three per cent. is solid matter, while in the saliva but one per cent. is found in the three or four pounds (see page 35). Preparation is clearly made for an important chemical change.

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* Beaumont, *Experiments and Observations*, &c. Boston. 1834.

In the above paragraphs attention has been directed to the stomach as one great compound gland with a single office. But it must not be unnoticed that there are considerable differences, certainly in degree and perhaps also in kind of development, among the secreting structure of different portions. The mucous membrane is thinnest in the cardiac end, where it measures from $\frac{1}{6}$ to $\frac{1}{4}$ of a line, in the middle of the curvature it is $\frac{1}{2}$ a line, and near the pylorus from $\frac{3}{4}$ to 1 line in thickness; which variation is wholly due to the glandular texture, for the epithelium and other parts are the same throughout (Kölliker). The more strongly developed glands at the pylorus have an appearance in some places similar to the arborescent or grape-like glands described in the mouth (page 56). Mr. Ecker has described and figured them as such since the publication of Professor Kölliker's work. Besides these there are in young subjects a number of small *lenticular* glands, resembling in structure the intestinal patches of Peyer.*

There is considerable difficulty in the human subject in gaining an opportunity of ascertaining whether these differences in thickness are simply differences of degree of development, or whether the kind of gland is distinct in the several parts. A perfectly healthy human stomach, opened immediately after death, is always likely to be too great a rarity for a rapid conclusion to be formed upon it. But in some animals it appears, from Professor Kölliker's observations and beautiful woodcuts, that the glands which hold the true stomach cells—the "gastric juice cells"—are confined to the cardiac extremity and the middle of the organ, while the pyloric end is occupied by similarly shaped glands without the same provision for peculiar secretion. In the former the cylinder epithelium continues for a short way down the duct, but when it gets to the said "gastric juice-cells," ends in a single layer of angular cells forming a lining membrane. At the pylorus the glands are lined with cylinder epithelium throughout, and have no "gastric juice-cells." As before said, similar or analogous differences in structure await confirmation in our own species.

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* Kölliker's *Mikros. Anat.*, ii. 2, 149, 150. *Ecker* in Henle's *Zeitschrifte für Rationelle Medicin.* N. F. ii., 243.

Besides the stomach cells and their presumed contents, there does not appear to be any other epithelium in the tubular glands. But mixed up with the mucus on the free surface you will perceive generally a number of short, stave-like particles, somewhat resembling broken bits of tobacco pipe, bigger at one end than the other, and with a nucleus at about the centre. These are "cylinder epithelium," the scales of which are attached in the normal condition during life by the smaller end to the mucous membrane, but they adhere so slightly that even the best manipulators can hardly ever make sections in which they can be seen *in situ.* They can, however, be sometimes detected adherent, as described. The probability is that they clothe the outlets of the tubular glands, and all the small intervening surface between the glands.

The cylinder epithelium-scales appear to be hollow tubes filled with a fine grainy matter; and some, where the end is knocked off, look as if they had a hole at one extremity. But in these minute objects so many ocular delusions occur, that it is hazardous to build upon our perception.

Whether they have holes in them or not, there seems much probability that they are connected in some way with absorption. It is in the stomach we first detect them, and it is there that absorption really begins in earnest. They are more developed in the intestines, and there we find that the same business is carried on more extensively still. The exact nature of the connexion they have with it is yet quite unknown and unconjectured.

SECTION III.—*The Lymphatics of the Stomach.*

The rapidity with which fluids disappear from the stomach leads to the probable idea that it is the rapid blood circle which they directly enter. Absorption by the veins seems to take place to a great extent, for there is nothing else which could manage it so quickly. But in the stomach, first, our attention is attracted by another slower moving feeder of the stream—the lymphatic system. This is one of those things easier seen with the naked eye than with the microscope. The lymphatics in a large animal felled soon after a meal in a slaughter-house are visible enough, wandering white over either curvature; but they are not to be put under a glass. They are described by Fohmann as forming two layers in the mucous membrane,—a deep and a superficial one.*

No great supply of food can be taken up by the slow motion of the lymphatics. But yet other things, perhaps more important to the nurture of the body—fibrine and albumen—are conveyed by them. We shall have a better opportunity of examining this question when we come to the intestines, where they are so much more fully developed. However, as they do exist both in mouth, gullet, and stomach, and in the latter especially are more conspicuous during the presence of food, it was right not entirely to pass them over here.

The stomach, then, is a much more perfect and self-dependent organ than what we have previously seen of the digestive canal. It produces a large quantity of fluid, and it takes up a large quantity of fluid: and from the long stay of the solid food there, it has plenty of time to do it in. At the same time, from the power which its secretions and the secretions of previous glands possess of preparing substances for absorption, there is much more to take up. A still greater facility of abstracting from the mass substances suitable to it, is afforded by the churning revolving motion which the muscular coat of the stomach produces in the contents. Read Dr. Beaumont's graphic description, and see how each portion must be successively submitted to the mucous influences. "After passing the œsophageal ring, it moves from right to left, along the small arch; thence through the large curvature, from left to right. The bolus, as it enters the cardia, turns to the left, ... descends into the splenic extremity, and follows the great curvature towards the pyloric end. It then returns in the course of the smaller curvature, and descends into the greater curvature, to perform similar revolutions. These revolutions are completed in from one to three minutes. . . . . . They are slower at first than after chymification has considerably advanced." So that if food remains in the stomach three hours, it will have been gently churned round two or three hundred times, and hence can easily be conceived to be incorporated into a pretty uniform mass, while at the same time there is a continual bedewment of its surface by the gastric juice poured out on all sides, and a continual removal of the more fluid parts by absorption.

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* Fohmann, *Sur Les Vaisseaux Lymphatiques*, p. 17.

SECTION IV. A.—*The Gastric Juice.*

The fluid secretion which is churned up with the food in the stomach, consists of a mixture of saliva and gastric juice. It is this mixture which Dr. Beaumont saw incorporating itself with and dissolving the mass, during its constant and repeated revolutions round the stomach of the Canadian voyageur, which he was enabled by such a singular fatality to inspect, and upon which the observations of Dr. Robertson of Edinburgh,* and Drs. Grünewaldt and Schröder of Derpt,† have been made—less perfectly, because of the small size of the fistula, but more instructively because of the advances of science since Dr. Beaumont's day. It is the action of this mixed fluid upon the aliments of different natures that they have recorded. It was this which Professors Tiedemann and Gruelin obtained by killing dogs, and Drs. Spallanzani, Braconnot, Leuret, and Lassaigne, by means of sponges tied to a string, which could be swallowed and brought up again. Practically, too, it is this mixture which we have to reckon on as that to which our meals are exposed during their protracted stay in this viscus. Drs. Blondlot and Bardeleben obtained it for experiment by means of making gastric fistulæ in dogs, and so added much to our knowledge of the reactions of this compound secretion.

Yet, for every purpose, it is no doubt better to have a distinct notion of the secretion of the stomach *alone*, to know what power, if any, the saliva adds to it, and what it possesses independently. At the Derpt laboratory, therefore, they have made a great stride, by tying the saliva ducts before the gastric juice was collected for observation; and the experiments made there by Drs. Hübbenet, Bidder, and Schmidt, have a peculiar value given them by this ingenious device, applied when the physiological reaction of gastric juice by itself requires study. Whenever, then, they speak of "*pure*" gastric juice, it is understood to be obtained from an animal with a gastric fistula, and with all admixture of saliva prevented by the operation above mentioned. The animals thus treated were two dogs and a sheep.

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* *Edinburgh Monthly Journal.* 1851.

† *Disquisitiones de Succo Gastrico Humano Ope Fistulæ Stomachalis institutæ.* Dorpati. 1853.

SECTION IV. B.—*Appearance to the Eye.*

The following description of the more obvious qualities of the secretion in question, is from the pen of Dr. Bidder:—"Fresh gastric juice, even when the animals have been kept for twenty-four hours or more without nourishment, is never quite pure, but is contaminated by remains of food, hairs, and the like, which have been swallowed. Often indeed there flows out in great drops from the canula, a perfectly clear and transparent secretion, but unfortunately this generally soon becomes troubled by the admixtures above mentioned. Through them the gastric fluid of the dog is, as a general rule, tinged of an ash grey or brownish hue, while that of the sheep looks grass-green or olive from the abundant remnants of their vegetable diet. In sheep, such admixtures are much more conspicuous than in dogs, because the store of food which is detained in the first stomach is still considerable after thirty-six hours' fasting, and is constantly passing into the rennet stomach in small detachments. The fourth stomach, therefore, would seem to be in a continuous state of activity, and hence we are able to account for the proportionably greater amount of its secretion in sheep than in other animals. Filtered gastric juice was always a clear transparent fluid, in the dog limpid or yellowish, in the sheep of a clear brown colour. What remained on the filter was a mixture of very various substances. There were to be seen under the microscope fragments of digested muscular fibre and areolar tissue; fat globules coagulated by cold or still fluid; starch granules, which became blue with iodine; pieces of broken-up vegetable tissue, which last, in the sheep, were the chief constituents of the mass. Of rarer occurrence are the large flat epithelial scales from the mouth, which in dogs with the salivary ducts tied, were to be found especially in the frothy tough lumps of mucus (see before, page 69) which in fasting beasts were emptied out with the contents of the stomach, swimming on the fluid secretion. Still rarer, and quite exceptional, were the cylindrical epithelial scales of the gastric mucous membrane. But there were constantly present larger or smaller accumulations of rounded bodies, one three-hundredth of a line in size, unaffected by acetic acid, which were imbedded in, and held together by a tough structureless transparent mass."*

A description, so similar that it is not worth repeating, of the appearance to the eye of the gastric juice of a healthy Esthonian peasant with a fistulous opening into the stomach, is given by Dr. Grünewaldt in his recent disquisition lately quoted; and indeed it differs in no important particular from that of the Canadian by Dr. Beaumont; so that we may consider that all the more minute particulars recorded above of the dog's would be equally true of human gastric secretion.

SECTION IV. C.—*The Stomach Cells.*

It is the rounded bodies above mentioned, which have been already described under the name of "rennet cells" (see before, page 74), as being visible in the pocket-shaped glands of the gastric mucous membrane, and also in the mucus which covers it during digestion. They are so peculiar in their appearance, that one feels disposed to associate them with the special functions of the stomach, and to view them as the "*peptic ferment*," the material cause of gastric digestion.

However, in a strict sense (that is as *solid bodies*) they are not so; for the filtered solution of stomach or of gastric juice, without a trace of morphic elements, was found by Dr. Bidder to be as efficient a digester as the fluid in its original state.

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* *Die Verdauungssäfte*, pp. 38, 39.

But this is no evidence against their containing the rennet in a soluble state in their interior, invisible perhaps from its transparency, and when discharged by the rupture of the envelop diffused through the surrounding liquid. The envelop itself, from its thinness and delicacy, we could hardly expect to be discovered when empty. This latter seems to me the most probable view of the case, as it allows full force to the facts observed by those who consider the presence of the "rennet cells" necessary to digestion, and those who would have the gastric juice secreted without them.

Dr. Frerichs in his article on "Digestion," gives the following as his idea of the process. He thinks that during fasting the "rennet cells" accumulate in the tubular glands, and that if food is taken at the proper time, they are discharged whole, and lying among the mucus, or forming the mucus, are gradually disintegrated, affording thus a constant supply of ferment. The tubes then collapse, again to accumulate their contents during abstinence, during which no full-grown cells escape from them.

There is in this nothing inconsistent with the observation of Dr. Kölliker, that in some animals no "rennet cells" are to be found in the mucus. They may be broken up in the glands in some animals as a rule, and in some as an exception.

The invariable presence of some remains of food in the stomach is an interesting fact. It seems to show that alimentary matters find a difficulty in proceeding along the canal until they have been subjected to the peculiar actions of its secretions. It explains why, when secretion has been suspended in the stomach by some pathological condition, the last meal so often does not pass into the bowels and cause diarrhœa, but delays, in expectation of the gastric juice, and when that is not provided, is rejected by vomiting, unchanged.

The other elements besides the food, seen in the gastric juice, cannot be considered as part of it. They are sometimes, as stated in the passage quoted above, entirely absent, and in a state of health are to be found in the smallest quantity. When, however, from irritation, a great quantity of mucus is secreted, then at the same time these are present to a considerable extent, and the efficiency of the gastric juice is diminished. They seem to make the fluid alkaline, or at least neutral, and to destroy its peculiar solvent powers.[*]

SECTION IV. D.—*Acidity of the Gastric Juice.*

The reaction of what may in a strict sense be called "gastric juice," is well known to be always acid. In the woman with gastric fistula observed by Dr. Grünewaldt, it was as a rule always so, except under certain disturbing circumstances. The knowledge of these may be of use to us in explaining the neutral or alkaline condition of the contents of the stomach which we from time to time find in our patients. The circumstances were

1. *Long rest and abstinence.*—The gastric juice taken from the fasting stomach was seldom acid, the small quantity secreted probably having been neutralized by the saliva swallowed.

2. *Mental annoyance.*—Dr. Grünewaldt attributes this to the tears and nasal mucus being swallowed; but the observation of Dr. Beaumont, that anger and other mental emotions stopped the secretion of gastric juice, would seem to indicate the likelihood of a suspension of the natural flow of the acid liquid from such a cause, as the true explanation.

3. *The presence of much mucus.*—This may act in two ways—viz., by obstructing the flow of the juice, and by neutralizing it when it has been excreted. It explains the not uncommon occurrence of alkaline vomit in diseases which increase the flow of mucus.

Though alkaline or neutral only under the above named circumstances, yet independently the degree of acidity appears to vary very much, without the possibility at present of any satisfactory explanation. Thus Drs. Bidder and Schmidt found that in a dog whose salivary glands were tied, and who lived wholly on flesh, 100 parts by weight of the fluid were saturated by from $\frac{260}{1000}$ to $\frac{426}{1000}$ of caustic potass—a limit of variation which was exceeded by that observed in a sheep, and that again by the comparison between a dog on vegetable and a dog on animal diet.

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[*] Wagner's *Worterbuch der Physiologie*, pp. 749—787. Kölliker, *Mykroskop. Anat.*, ii. 2, 144.

It may be considered as settled, that *for healthy digestion an excess of acid is necessary.*

What acid it is whose predominance is so necessary, has afforded a subject to exercise the observers of both the last and the present generation. The varying speculations concerning it, the number of times that philosophers entitled to the highest respect have "shown" opposite results, are calculated to point a moral of the fallaciousness of human learning. Several acids are present in the fluid examined with several bases—which identical one causes the acidity by its being free? Such would be the question if two persons always examined the same secretion. But suppose, as is the case, that they examine a different secretion in different animals, obtained by a different method—then a further question arises—is it always the same acid? Does not a different one predominate under different circumstances? and are not these acids, in various degrees perhaps, but still *all*, efficacious?

In dogs, it may be considered as settled, by the experiments of Drs. Bidder and Schmidt, that the necessary free acid in the healthy state is the hydrochloric. This is the result of eighteen experiments made upon the gastric juice of the animals named after fasting from eighteen to twenty hours, in all which there was found free hydrochloric, and not a trace of any organic acid.*

In sheep there was always found free hydrochloric, and mixed with it some lactic acid, but no more of the latter than was accounted for by the continuous presence of amylaceous food. The mineral acid was constant, the organic variable.

These experiments are so convincing, that Dr. Lehmann is even induced by them to surrender in the latter part of his work a very positive opinion which he had expressed in an earlier volume—an instance of candour which deserves to be recorded to the credit of science.†

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* The absence of organic acid is an important point; because Dr. Bernard has pointed out that lactic acid is capable of decomposing chlorides; and consequently, that if it is present, free hydrochloric acid may be formed from the kitchen salt existing in all secretions and in most food.

† "One result of Schmidt's analyses is that this admirable observer, in entire contradiction to my investigations, has not only detected *free hydrochloric acid*

Dr. Lehmann does indeed find lactic acid in the stomach of dogs fed before death, but then that may be the result of the decomposition of the food.

But what we have to do with is our own species—*hominem pagina nostra sapit.* And here, as the circumstances under which the stomach can be placed are more varied than in other animals, so the acid it requires to aid in its duties is more varied also. In that taken from Dr. Grünewaldt's patient under the same circumstances as that obtained from dogs—namely, *after abstinence from food*, Dr. Schmidt, in three analyses, could find no trace of free hydrochloric acid.[*] But in two subsequent analyses by Dr. Schröder, of gastric juice from the same woman, *after the stomach had been excited by the swallowing of some insoluble substances* (dry peas), there were found indubitable evidences of a calculable proportion (viz. 0·2 in 1000 parts) of hydrochloric acid and an absence of lactic.[†]

The examination of vomits in health and disease would seem, at first sight, capable of determining this question; and such observations might be made on a large scale. But it must be observed that we do not, in such cases, get the really natural secretion; the mere fact of the vomiting shows that the stomach contains something which is improper for it, or is excited in

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in the gastric juice of dogs, but also demonstrated beyond all doubt ***the absence of lactic acid*** in all the cases which he observed."—Lehmann's ***Phys. Chemie***, iii., 331, and i., 98

[°] ***Disquisitio de Succo Gastrico***, &c., auctore Otto à Grünewaldt, p. 47.

[†] ***Succi Gastrici Humani vis Digestiva***, &c., auctore Ernesto de Schröder, p. 37. Dorpati. 1853.

The annexed comparison of the quantities of muriatic acid found in several specimens of gastric juice, puts the matter in a condensed light:—

In that of dogs free from saliva (Bidder and Schmidt)...............	3·050	parts in 1000.
In that of dogs containing saliva (Bidder and Schmidt)...............	2·337	" "
In that of sheep containing saliva (Bidder and Schmidt)...............	1·234	" "
In that of human species fasting containing saliva (Schmidt).............	none.	
In that of the human species excited by insoluble substances and containing saliva (Schröder)................	0·2	" "

some abnormal way, and it is not fair to draw conclusions from such examinations.

On the whole the evidence at present seems to point to the conclusions (1st) that most probably *free hydrochloric acid is normally present in the healthy gastric juice when it freely exudes on the presence of a natural stimulus*; (2nd) *that it is present in much smaller quantities in men than in dogs*; (3rd) *that in men it may be easily neutralized and rendered undiscoverable by the gastric juice being overpowered by a comparative excess of mucus or saliva, normally in excess in fasting, abnormally so in disease.*

SECTION IV. E.—*The Ferment Substance.*

With the acid there is always present an albuminous matter coagulable at 100° Centigrade, which is absolutely necessary to the solvent powers of the gastric juice, and which thence has been named "Pepsin," or "ferment substance." Either name is good enough, if its employers will not necessarily attach any theory to it. It is, in fact, gastric juice without its water and without its acid, and therefore with its powers dormant though undestroyed.

The quantity of this substance contained in the gastric juice of different species of animals differs according to the nature of their food. Thus, in the analyses made in the Derpt laboratory, that of a sheep was not only more watery than the dog's, containing in fact only half the proportion of solid matter, but the solid matter contained also a much less proportion of ferment. In the sheep not quite 14 parts in 1000 consisted of solid matter, in the dog 28 parts: and of this solid matter but 29 per cent. in the sheep, while in the dog from 60 to 63 per cent. was ferment. In Dr. Grünewaldt's peasant, while under his care, the gastric juice contained 43·4 parts per 1000 of solid matter, and 36·6 of this was ferment.*

This fact seems partly due to the immediate circumstances under which animals are placed; for in a dog fed on vegetables the proportion of ferment in the solid matter was much lowered, viz., from the mean of 62 per cent., to about 48 per cent., but partly also to the natural constitution of the species, for at its minimum it was not so low as the sheep's maximum.

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* *Disquisito de Sueco Gastrico Humano*, p. 47.

In Dr. Grünewaldt's patient too, who while living in town in free quarters and taking full advantage of such comfortable circumstances produced the large quantity of ferment above named, a great change was made by a return to the spare diet of an Esthonian cottage. Dr. Schröder's analyses were made four months after Dr. Grünewaldt's, and when the patient had been at home some time; and then instead of 43 parts, but 5¼ parts of solid matter, and instead of 36 but 3 of ferment, appeared![*]

This subject seems to open the path to a series of investigations which would be of the highest scientific value, and most important in a practical point of view, leading to rational dietetics and discipline of the sick, and so offering the guarantee of "fruits and inventions" to the value of research. Yet the investigation is difficult, expensive, and painfully laborious. Observations continuously carried on, night and day, for many weeks, are indeed, as Dr. Bidder remarks, beyond the strength of one individual. When it is stated that in the prosecution of one part of their subject alone (the digestive power of gastric juice on albumen within the living animal), the Derpt Professors have recorded twenty-two series of independent inquiries, and twenty-three on its action outside the body, containing together as many as *a hundred and thirty-nine* experiments,—enough has been said to show not only that it is beyond the power of one individual, but that it is beyond the power of any number of individuals, if it is not, for the time at least, made the whole and sole business of life. When we add to this the natural, and with many the conscientious, repugnance to the required sacrifice of animal life, we shall easily understand why our knowledge is slowly augmented, and why what is newly acquired seems to many to bear a taint, like truths gained by the forbidden arts of necromancy or witchcraft.

The analyses from which I have made the foregoing deductions were conducted in the Derpt laboratory, and are fully detailed in the several works named. They consist of *ten* analyses of the gastric juice of a dog whose salivary ducts were tied, eight when he was on animal, and two when he was on vegetable diet; *three* analyses of that from a dog whose saliva was allowed to flow into the stomach, and *two* of the fluid from the fourth stomach of a sheep, by Drs. Bidder and Schmidt; three of human gastric juice on full diet by Dr. Schmidt for Dr. Grünewaldt, and two of human gastric juice on low diet by Dr. Schröder. In the table on page 88 are compared the totals of the several analyses above alluded to, with the addition of the proportions per cent. of the different solid matters, so as to show at one glance the results of the whole series of experiments.

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[*] *Succi Gastrici Humani vis Digestiva*, p. 87.

The chief points in the annexed analyses have been commented on in the larger type. We may remark however in addition the great excess of neutral salts, in proportion to the other ingredients, in the herbivorous animal. Their proportion per cent. in the solid residue is thrice what it is in the dog. All of the salts indeed are in excess, except those of lime, a difference from the others which is to be accounted for by the quantity of bones and other parts abounding in this base which dogs eat.

May it not be presumed that these varieties in the gastric juice of different animals and under different circumstances are an arrangement by which the body becomes accommodated to the changes and chances of life? May we not hope to learn much that is useful to us by more extended observations made in the careful manner of the Russian professors and their pupils?

Ultimate analysis does not give any assistance in explaining the peculiar action of the ferment. It is an "albuminoid substance,"—and that is perhaps all that can be said about its composition, for albuminoid substances do not differ in respect of their quantum of carbon, hydrogen, oxygen, and nitrogen, more than one chemist differs from another in his estimate,—is precipitated by bichloride of mercury and acetate of lead, and is decomposed by boiling and anhydrous alcohol. It may be separated from its compounds (*i.e.*, with mercury and lead) by sulphuretted hydrogen, and in that state exerts a powerful solvent influence over coagulated albumen.

On the observations made previously by Wasmann on this ferment or "pepsin," Dr. Schmidt, in 1847, in his work *Ueber das Wesen des Verdauungsprocesses*, grounded a suggestion, that the gastric should be looked upon as a conjugate acid, compounded of the ferment-substance and hydrochloric acid. This theory and the objections to it are fairly and fully stated in Lehmann's *Physiological Chemistry* (immediately after the last quotation). It is purely a chemical question, with no bearing at present visible on physiology, so to that book the reader may be referred. It answers our purposes better to view the free acid and the ferment, or "pepsin," as *separate parts of the gastric juice, dependent indeed on one another for powers of action but not for existence as substances.*

	Mean of ten analyses of gastric juice of dog without saliva. (Bidder and Schmidt.)		Mean of three analyses of ditto mixed with saliva. (B. and S.)		Mean of two analyses of gastric juice and saliva of sheep. (B. and S.)		Mean of three analyses of human gastric juice on full diet. (Grünewaldt.)		Mean of two analyses on low diet. (Schröder.)	
Water	973·062		971·171		986·147		956·595		994·350	
Solid residue	26·938		28·829		13·853		43·405		5·596	
	1000·000		1000·000		1000·000		1000·000		999·946	
		Proportion per cent. in solid residue.		Proportion per cent. in solid residue.		Proportion per cent. in solid residue.		Proportion per cent. in solid residue.		Proportion per cent. in solid residue.
Ferment or "pepsin"	17·127 ...	63·5	17·336 ...	60·1	4·055 ...	29·2	36·608 ...	84·3	3·195 ...	57·0
Hydrochloric acid . .	3·050 ...	11·3	2·377 ...	8·2	1·234 ...	8·9	— ...	—	0·200 ...	3·5
Chloride of Potassium .	1·125 ...	4·1	1·073 ...	3·7	1·518 ...	10·9	— ...	—	0·550 ...	9·8
. . . of sodium . .	2·507 ...	9·3	3·147 ...	10·9	4·369 ...	31·5	4·633 ...	10·6	0·964 ...	17·2
. . . of calcium . .	0·624 ...	2·3	1·661 ...	5·7	0·114 ...	0·8	— ...	—	0·061 ...	1·0
. . . of ammonium .	0·468 ...	1·7	0·537 ...	1·8	0·473 ...	3·4	— ...	—	— ...	—
Phosphates of lime, magnesia, and iron	2·037 ...	7·5	2·738 ...	9·3	2·000 ...	14·4	1·227 ...	2·8	0·125 ...	2·2
	26·938		28·829		13·853		42·463		5·095	

SECTION IV. F.—*Action of the Gastric Juice on Nitrogenous Food.*

Here lies the main business of the fluid as a solvent. Almost all the albumen and albuminoid matters,[*] submitted to the stomach are coagulated and insoluble in water. The gastric juice has to make them soluble. This task it accomplishes not by dissolving them in itself, and accompanying their course all along so as to keep them in a state for absorption—this indeed would serve the purpose, but the plan adopted is still more efficient: *the nature of the substances is changed;* so that in future, even when the gastric juice is all gone, they are of themselves independently still soluble. And this is done not to coagulated alone, but to uncoagulated albumen. The latter appears in its raw condition to be not fitted for absorption; and it is therefore, equally with the coagulated, formed into an independent new organic substance, which has been called "Peptone." In this state the nitrogenous matters are not only not coagulated, but they have lost the power of coagulating at all, or of setting into a jelly, or in fact acting in any way as they did before. "Peptone" is truly a new body, which is soluble not only in water, but in alcohol, if diluted, and does not any longer form insoluble compounds with the metallic salts.

> "Mialhe and Pressat have endeavoured to prove that fresh white of egg can penetrate animal membranes only when the latter have attained a high degree of decomposition : however, repeated experiments on different animal membranes, first treated with alcohol and afterwards with water, have shown us that for albumen, &c.. they are not absolutely impenetrable. What however is beyond all question, is that these substances go through membranes with great difficulty, and that their diffusion equivalent, as Graham has shown in the case of albumen, is exceedingly low (Dr. Graham found the equivalent of sugar 8½ times, and that of kitchen salt 19 times greater than

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[*] By "albumen," "albuminoid matters," and similar expressions in the subsequent pages, will be meant that group of organic bodies which, on Dr. Mulder's hypothesis, are called Protein compounds, viz., *Albumen*, as it exists in white of egg, serum of blood, &c. ; *Fibrin*, as in meat and blood ; *Vitellin*, as in yolk of egg ; *Globulin*, as in blood globules, the crystalline lens, &c. ; *Casein*, as in milk cheese ; *Vegetable fibrin* contained in the ferment of yeast, of almonds, &c. They are distinguished from glues and gelatin by their citron colour when heated with nitric, and their purple colour with muriatic acids, and other characteristics detailed in Dr. Lehmann's *Physiolog. Chemistry*, vol. i. "Protein Compounds."

that of albumen). On this lies the ground for the observation, that protein compounds, apparently all ready for use as nutriment, require a change by the digestive juices previous to absorption. Without the gastric and intestinal juices even soluble albumen and casein are taken up in far too little quantities to suffice for the nourishment of the frame."*

The agent in this formation of "Peptone" being the gastric juice, the essential property of which is to contain its peculiar ferment and some free acid, several points present themselves which the investigations of Drs. Bidder and Schmidt† do more to clear up than any that have preceded them. These are—

1. Is the action of the gastric juice in the body the same as it is out of the body? Has the contact of living membrane any influence over this mysterious fermentation, or can it be conducted also in a test tube?

2. Is the free acid *alone* sufficient to accomplish the solution or fermentation of albumen?

3. Is the fermentation at all proportionate in rapidity or force to the amount of free acid?

4. Has it any relation to the degree of ordinary decomposition?

5. Is the ferment a soluble or insoluble substance? that is, is it dissolved in the water of the gastric fluid, or does it consist of the organic forms (epithelium for instance) floating therein?

6. What is the effect of temperature above and below that of the body?

7. What is the effect of greater or less concentration of the secretion? that is, of the addition of water?

8. How does the admixture of saliva act? such as takes place in the normal condition.

9. The consequence of the admixture of bile? such as takes place in some pathological states.

10. In what amount can albumen be dissolved by gastric juice?

In the experiments which answer the preceding questions, the albuminous substance employed was freshly coagulated white of egg, of which a part was preserved to dry and estimate its aqueous contents. The rest was put into muslin bags, which were inserted, as the case might be, either into test tubes of the fluid to be examined, or into the stomachs of the animals through a gastric fistula. In the test tubes they were allowed to remain from eighteen to twenty-three hours, and in the inside of the living animal from two to six hours, and weighed on their withdrawal. The loss of weight tested the activity of the gastric juice. They were from time to time examined by the smell, to find if decomposition was commencing, and its occurrence noted.

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* Lehmann's *Physiol. Chemie*, iii., 338.

† *Die Verdauungssäfte*, &c. References to individual experiments are given further on.

Outside the body (*i.e.*, in test tubes) twenty-three specimens of gastric juice were experimented upon,—twenty from the dog's stomach, three from the sheep's. On these seventy-one experiments were tried. *Within the body* sixty-eight experiments were tried on twenty-two specimens of juice,—eighteen on dogs, four on sheep.

1. *Is the action of the gastric juice in the body the same as it is out of the body?*

The comparison of the two great classes of experiments made within and without the body shows that the action is the same in kind or ultimate result, but different in degree or rapidity. The conversion of coagulated into soluble albumen or peptone, occupies much longer time in the test tubes than in the stomach, so that in them it is very apt to become putrid before the action has ceased.

In sixteen experiments on the gastric fluid, the mean number of hours during which the white of egg was kept immersed in the test tubes was 18·43, and the mean loss of dry solid substance in 100 parts was 43·40, being 2·34 per cent. per hour.

Omitting two experiments of an exceptional character, the mean number of hours during which it was kept in the stomach of living animals was 4·06, and the mean loss of weight in 100 parts 44·96, being 11·07 per cent. per hour. (Omitting the two exceptional ones, the number of experiments was sixty-six.)

So that the conversion of the albumen into a soluble substance is effected nearly five times as quickly inside the body as out. To account for this, we have in the first place the constant motion of the live stomach, rolling the morsel round and round; and secondly, the flow of liquid secretion which washes away the soluble parts as soon as they become so, and submits a fresh surface to the influence. The resemblance *in kind* of the action inside and outside the body may be inferred from the similar solubility of the peptone formed. We have, in short, no evidence against the assumption, that what holds good of one action will *mutatis mutandis* hold good of another, and that for a comparative estimate of the relations of different substances to the gastric juice, experiments outside the body are valid.*

2. *Is the free acid alone sufficient to accomplish the solution or fermentation of albumen?*

These experiments were made with dilute muriatic acid alone on albumen, and after twenty and twenty-one hours only a quarter of the usual loss of weight under the influence of gastric juice was effected.†

3. *Is the fermentation at all proportionate in rapidity or force to the amount of free acid?*

It was found that neutral or alkaline juice, such as is to be obtained from starved animals, or from the stomach in a state of mucous flux, dissolved a very inconsiderable quantity of albumen: but that when the same fluid was again rendered sour with artificial muriatic acid, its power was restored. Again, natural juice could have its powers reduced by potash in various degrees, and regain it by the addition of acid. Again, the stomach of the dog was found to dissolve albumen with much greater rapidity than that of the sheep, being at the same time much more acid. Comparative reckoning of the quantity of albumen dissolved under different degrees of acidity still further confirms the deduction, that *the digestive force of the gastric fluid is in direct proportion to the acid it contains.*‡

These conclusions are of incalculable importance to us who profess by artificial means to modify the acts of the living body.

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* See Experiments i. 2—v. 2—vi. 1—xiii. 1, 2—xiv. 1. 2—xv. 1, 2, 3, 4—xvii. 1, 2, 3, 4—xx. 1—(pp. 76 to 80) and all the experiments inside the body except xix. 3 and xxii. 1—(pp. 81 to 83).

† Experiments ix. 3—xi. 3—xii. 2—(pp. 78, 79).

‡ Experiments ii. 4, 5, &c., in the first series.

4. *Has it any relation to the degree of ordinary decomposition?*

Within the body the albumen seems to have been so quickly dissolved that no fœtor was observed in it; but in the test tubes the phenomenon was frequently observed when the mixture was neutralized by potash. In these instances less loss of substance than in any others was found, so that ordinary decomposition, so far from assisting digestion, would seem either to impede it or to go hand in hand with its being impeded.[*]

5. *Is the ferment a soluble or insoluble substance?*

Repeated experiments were made, which show that filtered gastric juice, free from all visible forms of organic tissue, still possesses the powers it had before filtration; indeed, in some of the series of experiments (accidentally perhaps), it dissolved more than in the natural state. The ferment therefore is a soluble substance.

6. *What is the effect of temperature above or below that of the body?*

Eight trials of the power possessed by gastric juice, after being raised rapidly to the boiling point, and one of it concentrated to the consistence of oil at 212°, rendered it quite certain that heat destroys the ferment. Scarce any loss of substance occurred, and the appearance of the albumen was unchanged even after twenty-three hours. Low temperatures do not exercise, however, any deleterious influence; gastric juice, which was absolutely frozen in four instances, dissolved albumen as well as ever. "This," as Dr. Bidder observes, "must be a great comfort to the admirers of ices."[†]

7. *What is the effect of the greater or less concentration of the secretion?*

It has just been stated that concentration at a high temperature in the open air destroyed the properties of the juice. Such however was not the case when the temperature was lower, as when it was dried *in vacuo* over sulphuric acid. It could then be concentrated, and again diluted with water, without the loss of its power. There is here an hiatus in the series of experiments; one is required upon the concentrated juice *without* re-dilution.*

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[*] Experiments i. 3, 4, 5, 6—ii. 2, 3, 4—iii. 1, 2—iv. 2—v. 3, 4, 5, 6—vii. 2—viii. 2—xi. 2—of the first class.

[†] Experiments ix. 1, 2—x. 1—xi. 1—xvi.—xvii.

8. *How does the admixture of saliva act?*

Since to be mixed with saliva is the normal fate of the gastric juice, the question is a natural and important one. It appears that such admixture does not in any degree aid the solution of albumen. For in the experiments with the mixed secretions inside the living stomach of dogs, the per-centage of dissolved albumen was, on the average, by no means so high as when the salivary ducts were tied. Whilst in the latter the mean

Of 9 experiments for 2 hours, gave a loss of 29 per cent.;
Of 9 experiments for 4 hours, a loss of 62 per cent.;
Of 9 experiments for 6 hours, a loss of 76 per cent.

In the former the mean

Of 9 experiments for 2 hours, gave a loss of 26 per cent.;
Of 9 experiments for 4 hours, a loss of 45 per cent.;
Of 9 experiments for 6 hours, a loss of 65 per cent.

This systematic and regular difference cannot be accidental, and may be rationally supposed dependent on the relative neutralization of the juice by the alkaline saliva swallowed. Therefore where there is an excessive secretion from the salivary glands, either in the species or the individual, we may expect that starchy bodies indeed will be rapidly digested, but that albumen will become but slowly soluble.

9. *The effect of the admixture of bile*, even when not to the extent of neutralizing the acid of the juice, is utterly to annihilate its powers. Indeed, in three experiments not only was there no loss, but an actual increase in substance of albumen, a circumstance probably due to the difficulty of washing the bile away.†

10. *The amount of albumen which the gastric juice* is capable of dissolving is not well shown by the series of experiments that have been quoted. Though convenient as a medium of comparison, the solid white of egg is not in a form fit to allow the full action of the ferment. This is clear from a series of two experiments in which beef was used, and where, even when

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* Experiments xix. 1, 2, 3.

† Experiments xiv. 3, 4—xx. 2.

alkaline and out of the stomach, the juice dissolved considerably more than the average per-centage by weight of the substance. Hence, Drs. Bidder and Schmidt freely allow that their reckoning of 2·2 parts of albumen as the amount capable of being converted by 100 parts of juice, is much too low, and that Dr. Lehmann's estimate of double that quantity is probably nearer the truth.

SECTION IV. G.—*The Gastric Juice in the Human Species.*

The quantity of gastric juice secreted in twenty-four hours has been already stated to have been determined by Drs. Bidder and Schmidt in the case of dogs to amount to about a tenth part of the weight of the body. Assuming the same to hold good of our own species, a man of ordinary size would daily secrete fifteen or sixteen pounds of the fluid. But it must be recollected that the habits and diet of different animals are so different, that what is true of one race is by no means necessarily true of a second, and individuals even may, in a minor degree, be supposed to differ one from the other.

Astonishment has naturally been expressed at the enormous activity of the circulation through the mucous membrane, and it has been questioned whether it is not something peculiar to the animals operated upon, or to some oversight of the operator. In fact, no one is willing to believe that he has all his life been secreting daily an amount of fluid so greatly exceeding former calculations* without knowing anything about it.

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* Dr. Lehmann had reckoned the secretion of gastric juice in a man at four pounds only *per diem*. His estimate is made in the following way :—

100 parts of fresh gastric juice from a dog effect the conversion of 5 parts of dry albumen :

An adult man takes into his stomach about 3¼ ounces avoirdupois of dry albumen in twenty hours :—

Hence to render that quantity soluble there is required not above 4 pounds of juice.

The steps of the argument open to fallacy are the following :—

First, it is assumed that human gastric juice is as strong a solvent as canine.

Secondly, it is assumed that no more gastric juice is poured out than just enough to contain the solvent for the required amount of food. This is unlikely, because we know that most animals in good circumstances frequently take more food than they require, and yet they are able to dissolve it ; and therefore it is

Great interest therefore attaches to the opportunity lately afforded to Dr. Grünewaldt, of measuring the gastric juice of our race, in a patient with a stomach fistula, which had existed from childhood, and did not in the least degree interfere with the general health.

Dr. Grünewaldt obtained from this individual, on an average of sixty-two hours, at different periods of the day, 584 grammes an hour of gastric juice.[*] This gives fourteen kilogrammes, or nearly thirty-one pounds avoirdupois, as the quantity secreted by a stout healthy person of fifty-three kilogrammes weight, in twenty-four hours.

If our astonishment was excited by the experiments of Drs. Bidder and Schmidt, how must it be doubled by this confirmation of them on the human species, who secrete not one tenth, but, according to this calculation, nearly one-quarter of their weight of gastric juice daily?

It is to be observed truly, that the individual described had a very large appetite, and thought it a duty to take advantage of the free commons afforded; but against that possible augmentation of the usual quantity may be reckoned that which, under every precaution, would not fail to escape from the pylorus and be lost. It is difficult not to conclude that the human stomach exceeds much the dog's in the amount of its secretion.

What an importance this consideration attaches to the stomach! From the membrane which lines that comparatively limited space, there is fluid daily exsuded equal in quantity to the whole measure of the blood, to a fourth of the weight of the body! How essential must be the health of this part!

The variations in quantity during health, as far as known,

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probable that they make habitually more than a bare sufficiency for ordinary occasions. Great quantities of gastric juice must keep constantly oozing out of the pylorus, and being wasted, so far as stomach digestion is concerned. Much too is neutralized by the alkaline saliva. Then it is to be observed that Dr. Lehmann has reckoned only for the solution, and not for the continuous intermediate circulation through the mucous membrane.

[*] *Disquisitio de Succo Gastrico Humano Ope Fistulæ Stomachalis indagatæ*, auctore Otto à Grünewaldt, p. 35. From the whole quantity passed out through the fistula a deduction was made for saliva, the probable amount of which was estimated, as far as possible, by experiment.

seem solely dependent upon the demand. In Dr. Grünewaldt's patient, after rest and eating, as for instance in the morning, a minimum was found, and that little was alkaline, probably from the saliva swallowed; when food was taken or anticipated, it was copious and acid; the same indeed was observed in the dogs of Drs. Bidder and Schmidt, and is probably traceable to the psychical influences of the nervous system over the secretions:—when the mind was dormant, the stomach slept too, when its attention was directed to the necessity for forming gastric juice, the organ was in full activity.

Herein probably lies the advantage of rest and relaxation before meals. The hurried merchant, who bolts his food as a parenthesis between two entries in the ledger, has no gastric juice ready to digest it; while "the man of a good heart," who, as the son of Sirach says, "hath a care for his meat and diet," and consequently gives himself time to anticipate dinner with some pleasure, gets his stomach and salivary glands into a state equal to their duties.

The leading points in the physiology of the gastric juice, made out by the experiments of Drs. Bidder, Schmidt, and Hübbenet, upon that of dogs, appear from corresponding trials made by Dr. Schröder in the just quoted case of gastric fistula to hold good of men also.[*]

The principal differences seem to depend on the fact—that in our species, whilst the saliva is much more powerful, both in its peculiar action in converting starch into sugar and in arresting the activity of the gastric juice, the secretions of the stomach on the other hand are weaker in their influence on albumen than in the canine race.

This slower dissolution appears clearly from the following comparison of two sets of experiments:—

Dr. Hübbenet found that coagulated white of egg introduced into the stomachs of dogs, lost

in two hours 21·17 per cent of its weight,
" four " 46·80 " " "
" six " 77·13 " " "

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[*] *Succi Gastrici Humani vis Digestiva*, auctore E. Schröder, pp. 24—32.

While in the stomach of the patient with gastric fistula, Dr. Schröder found that it lost

in five hours only 23·6 per cent. of its weight,
" eight " 39·13 " " ".

These observations by the balance were further confirmed by those made with the microscope. Dr. Schröder found that two hours in a dog's stomach disintegrated muscular fibre as much as three and three-quarters in the human stomach; and that this was even more striking in short periods, for an hour in the dog's stomach produced a swelling of the ultimate fibres, and destruction of sarcolemma, such as was never seen at all in the human; and even five minutes, by which no impression at all was produced in the human stomach, had in the dog's denuded the bundles of muscular fibres of their cellular envelope.

So striking is this difference, that Dr. Schröder doubts whether meat is *ever entirely digested* in the stomachs of our species, and whether its complete disintegration is not left to the action of the intestines; though in dogs he has no hesitation in allowing all albuminous matters to be entirely soluble in the gastric juice.

It is impossible not to connect this deficiency in one animal and superiority in another, with the differences before noticed in the acids which are found in the secretion. Dogs have been already stated always to secrete hydrochloric acid in considerable quantity, while men, when they secrete this acid at all, do so to a much less extent. Now, in no other important respect are the gastric juices different from one another in a chemical point of view. When, then, we further know that hydrochloric acid, even alone in the laboratory, has a very potent solvent effect on muscular fibre,* there seems no way of avoiding the conclusion that it is through its influence that we are surpassed in our digestive prowess by the canine race.

It might be thought that the inferior solvent power over albumen of human gastric juice may be partly dependent on a greater state of dilution, as well as on its want of acid. We have read (page 96) that man pours forth nearly a fourth part

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*Well shown in Otto Funke's *Physiolog. Atlas* to Lehmann's *Phys. Chemie*, pl. xv.

of his weight, and the dog only a tenth of his weight, of this fluid daily; and we might therefore suppose the former to be more watery; but such is not the case; for from the analyses of Dr. Schmidt and Dr. Grünewaldt's patients' gastric juice, compared with that of dogs under equal circumstances (that is, full diet), it appears that in fact the canine is the most dilute of the two (page 88). It is probable that the carnivorous animal excels us principally by the acid he is able to secrete.

It is obvious that the great activity and high solvent power of the gastric juice must be of great advantage to an animal, which even in the domestic state and still more in the wild state, can only get food at long intervals, and must then lay in a large stock, and which is obliged to disintegrate solid tough flesh and bones in an unprepared condition whenever it can get them. It would be interesting to know whether hereditary domesticity has at all diminished such virtues, and whether wolves, hyenas, &c., do or do not possess them in still greater perfection. A further subject of inquiry interesting to science would be, whether art might change nature; whether habituation to vegetable food might in one or two generations increase the solvent action of the dog's saliva and diminish that of his gastric juice; whether a converse experiment might have an opposite effect in a sheep, &c.

There are three practical reflections which this superiority of dogs to men suggests; two physiological, and one medical. The first is that, not being fitted for the wild carnivorous state, we must not attempt to live as if we were. We must not gorge meat largely at rare intervals, and then go without food till the time comes round for our infrequent heavy meal; but we must give moderate and frequent employment for that gastric juice which we can *always* indeed make, but not *in large quantities*. We must also not forget to mix with it a full proportion of that vegetable diet which our stronger saliva enables us to digest better than purely carnivorous animals.

A second physiological reflection relates to the quantity of water natural to our gastric juice. Had it been merely the dilution which made it weak in power, we might increase the strength in some degree by abstaining from diluents during meat meals; and in fact, on theoretical grounds, advice to this effect has been given; but practically it does not answer, except in cases where persons had previously been in the habit of overgorging—they indeed, by leaving off drinking during food, are forced to eat less—but for rational feeders the advice is injurious, and a moderate meal is certainly easier digested when diluents are taken with it. Experimental philosophy now explains the result of practical observation.

The medical reflection is, that where from circumstances gastric juice is either absolutely or relatively deficient—either too little being secreted, or too little to dissolve the quantity of food required to be ingested—then acids, especially the muriatic and lactic, seem especially indicated as medicines.

CHAPTER V.

THE SMALL INTESTINES.

Immediately after the pylorus the papillary arrangement of bloodvessels is again adopted, and carried out to its fullest development in the villi. It is no difficult matter to inject them, and fair specimens may be seen in every museum. The exquisite velvetty surface thus produced is one of the most beautiful objects possible, and gives some faint notion of the glow of healthy life in the same quarters.

Section I.—*The Epithelium of the Small Intestines.*

The pile is here so long and the epithelium so thin, that it does not fill up the interstices so as to produce a smooth superficies, but follows the whole projections and depressions, and is a complete cast of the shape of the villi.

This extreme delicacy of texture, combined with liability to change by chemical agents, even by water, seems to be the reason why the epithelium in these parts has only of late years been detected, and is a grievous impediment to the improvement of our acquaintance with it. We know however enough to recognise its prime importance in the act of absorption.

Absorption has hitherto been spoken of with reference only to water, and things soluble therein. It has been described as passing through solid organic membranes in accordance with a series of laws called endosmosis. But this inter-penetration of substances one into the other athwart organic solids saturated with water, is shown in dead membranes only in the case of the substances being dissolved. We have but little experience, it is true, concerning a similar transmission of insolubles, nor are its laws yet investigated; but the facts can hardly be doubted. I have before alluded to the subject as regards membranes in general (see page 26), but perhaps the most striking instance of this transmission of insolubles is afforded by the intestinal epithelium. Fat or oil, whose antipathy to water points a proverb, can be seen in its passage *through* the individual cells—I mean not *between* the cells, but *in* the interior of their substance. In an animal killed after an oily meal, many of the villi are seen studded over with pearly drops, glistening and refractive. These drops are seen to be oval, and to be just the shape that the epithelial cells would be if distended like full bags. Other villi are quite dark by transmitted light, and show white by reflected light, being in fact quite filled with oil in round drops. Loose cells distended by oil may also be found floating.

At the same time milky (that is oily) chyle appears in the lymphatic vessels, and an increased amount of fat in the portal blood.

So that the passage of oil through the coat of the cell into its interior, and backwards into the lymphatic and blood vessels, is brought under the cognizance of the eye.

The stages of this passage are traced by Professor Kölliker as follows: "The fat of the chyme penetrates at first only into isolated epithelial cells in different parts of the villi, so that in each of them there is soon to be seen a large glittering oval drop. Soon the number of these cells with fat in them increases, and then the villi take on all sorts of various appearances by reason of the irregular varieties of cells, some filled with fat, some shining quite clear, and some empty and flat. Often the villi look as if they were set with pearls. At last all the cells get filled with these drops, and the epithelium by transmitted light appears quite dark, by reflected light whitish, and that colour is then general throughout the whole villus.

"With this repletion of the whole epithelium, absorption commences, although in this stage the lymphatic vessels contain nothing yet. What however is the first thing observed is a breaking-up of the great oil-drops in the cells into a multitude of moderately fine oil-molecules. When this has taken place, these droplets, (viz., the molecules) penetrate through and through on all sides into the parenchyma of the individual villi, fill it continuously more and more, and arrive at last at the interior of the central chyle vessel, of which they fill the entire length. Meanwhile the intestinal canal is continuously pouring in new fat, not however in the form of large drops, but henceforth only little molecules or droplets, of the same sort as were formed in the cells in the second stage. On the other hand, they are visible on a later view occasionally in the interior of the villi, great round oil-drops, which, especially at the end of the villus, attain a greater development.

"I have not been able to trace this process step by step in the human subject yet, but here too there are to be seen, in the first place cylinder epithelium filled with oil-molecules, and secondly collections of larger and smaller oil-drops in the parenchyma of the villi, especially at the tip and centre of them. So often has this been the case, that I have not the slightest hesitation in assuming the same phenomena to take place in man as in other animals, without however pronouncing absolutely that each identical phase above drawn is exhibited here."*

In order to account for water and oil being both transmitted through the membrane, and perhaps other matters also equally incapable of union, it has been suggested that some of the epithelial scales are suitable for one substance and some for another. The opinion has been ascribed to Professor E. H. Weber, but his words as quoted by Professor Lehmann, do not bear out the justice of the ascription. The following experiment by Drs. Bidder and Schmidt seems at all events to bear strong testimony against the idea. Butter deeply stained red by boiling with alkanet was administered to some cats. This dye-stuff is well known to perfumers and others to be soluble in oil but not in water, not being liable to be washed out by the latter, so that it is suitable for rendering perceptible to the eye the road the fat takes, and enabling us to decide whether the absorption is restricted to particular portions of the epithelium or not. The cats were killed, and some of the intestinal villi brought rapidly under the microscope. The epithelial cells were seen exhibiting a decided colouring, not indeed red, but yellow from its extreme diffusion, just as is the case with blood when the globules are looked at in small masses. This coloured matter was shown to be fat by the high degree in which it refracted light, and was evidently inside the cells and not out. Well—this colouring was spread *in equal proportion throughout the whole number of cells,* and not in greater quantity at the tip or any other place in the villus, showing that all the scales were equally concerned in the action.†

SECTION II.—*The Bloodvessels and Lymphatics of the Small Intestines.*

It may be noticed that I have already associated together the bloodvessels and lymphatics as parts of the same system. Not without design, for in truth it is impossible to separate the physiological offices of the two in respect of the subject now engaging our attention—at all events, in the present state of our knowledge. They are both absorbents, and as far as we can now judge, the lymphatics occupy the position of assistants, not indeed absolutely essential to the bloodvessels, but vastly increasing their efficiency.

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* Kölliker, *Mikros. Anat.*, ii. 2., pp. 167, 168.

† Bidder and Schmidt, *Die Verdauungssäfte*, p. 280.

The fine rootlets of a tubular system, which commences in the centre of the villi and terminates in the lymphatic vessels visible to the naked eye, are not easy to see, on account of their transparency under ordinary circumstances. Hence those who have described them have rested on a very few original observations. The consequence is, as might be expected, that we have different opinions expressed concerning their shape. One set of observers say that in the human subject they commence by a single root, which forms the axis of each villus; another set that there is a plexus of ramified roots in the same situation; another that there are two or more roots in each. It seems agreed that in different animals these varieties occur, so that clearly no one absolute type of form is necessary, and it is not impossible that all may be found in the same subject on further investigation. Such a possibility is rendered more likely by the universal irregularity of the lymphatic system as regards external form, and the variations which occur in it without interference with its general efficiency. It is possible, too, that the nature of the food in different animals may either cause or require a special form of absorbing capillary, that omnivora may have all forms, and that the predominance of one or the other may be associated with individual peculiarities of growth or appetite.

Professor Kölliker gives a list of the different observations made in regard to this point, and concludes them by the following statement of his own experience: "I have by my own investigations arrived at a definite conviction that in many of the villi there is but one rootlet, although in all the filiform and cylindrical, as J. Müller supposes, I cannot assert such to be the case. Like Müller, I employed ruminant animals in these investigations, particularly the calf, which often exhibits the villi filled with white chyle. . . . . . A dilute solution of soda is a capital medium for making this vessel visible through its whole extent, and shows its contents yellowish, finely granular like fat, and lying in a line quite separate from the membrane. Of branches and plexuses not a trace is to be seen; and after the examination of a number of villi, where the chief vessel is most obvious, the conviction becomes all the more certain that there is but that single vessel; and the examination of other mammals makes the impression still stronger." He then explains how easily a row of fat globules lying in a consecutive form may be taken for a vessel, and if these are curled round at the end of the villus, how closely they resemble a coil, or plexus. He suggests also the possibility that the muscles of the villi might be mistaken for tubes. The Professor will not allow anything to be a vessel unless it can be shown to have distinct walls.

In the human subject he says he has been equally unable to detect plexuses or network, but he attributes less weight to these observations, because he has never obtained an example of the satisfactory filling of the villi in them. In birds he has been equally unsuccessful in detecting ramifications of these lacteals or lymphatics of the villi.*

In the capillary bloodvessels a most powerful aid to absorption exists in the rapid stream which is pushed from behind and down forwards in front through them. But the same does not take place in the lymphatic system; the only current being formed by the very fluid which is entering through its walls. The flow, therefore, as respects the water at least, may be expected to be much slower. But *how much slower*—how much, that is to say, of the circulating twenty-one to twenty-five pounds of fluid is taken up directly by the bloodvessels, and how much is contributed to the blood indirectly through the thoracic duct—is unknown.

The modes adopted for reckoning the amount of chyle are a good example of the difficulties attending physiological estimates. To enumerate authorities, saying that one man, professor at such an university, thinks one thing, and another equally distinguished observer thinks another, makes physiologists appear in the light of mere guessers, and certainly lowers the science in the eyes of the unlearned. But to state the reasons and arguments which have led to their forming such estimates places them in a much better position. Ample excuse is shown for their differences of opinion, and the just merit of judging rightly on the light which they possess is awarded.

Mr. Cruikshank estimated the amount of chyle which passes through the thoracic duct at 4 pounds an hour. This estimate is grounded on the rapidity of motion in the lacteals of a dog's mesentery. This was four inches a second, and the same pace he concluded was continued in the thoracic duct. Now, besides the doubt which attaches to the latter assumption, an experiment of this sort on a living animal is fallacious, from the disturbance it must produce in the ordinary motion of the chyle.

Mr. Magendie opened the ductus thoracicus in the neck, and observed how much flowed out in five minutes. Dr. Bidder repeated his experiments with similar results. But it is to be remembered that by this process we remove the impediment which a closed vessel presents to the flow of a contained fluid, and allow it to proceed too quickly—we are in fact removing the end of the cask and expecting the contents to flow at the same pace as out of the tap.

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* Kölliker's *Mikros. Anat.*, ii. 2, pp. 163, 164.

Herr Vierordt proceeds on quite a different plan. He supposes that about 3½ ounces of dry nitrogenous matter is eaten by a man daily; the chyle contains not above four per cent. of such matter; so that reckoning it all to go in by the chyle, the amount of the latter would be 5¾ pounds avoirdupois in the twenty-four hours. The uncertainty here lies in the doubt whether all the nitrogenous aliment really does enter by the lacteals alone, and also in the omission in the estimate of the lymph contributed by the absorbed tissues of the body through the general lymphatic system.

Very similar difficulties would attend the estimate which might be made on this principle from the quantity of fat eaten and the quantity contained in the chyle, for direct experiments show still more decidedly in this case than in that of the nitrogenous aliments, that much enters directly into the venous capillaries. For example, it has been found that after food the blood of the portal system exceeds the rest of the system in the quantity of fat it holds, more than after fasting (*Schmidt*).*

The comparative estimate of the matters taken up by the blood capillaries directly and by the lymphatics in the intestinal canal, is almost as difficult in respect of *quality* as it has been just stated to be in respect of quantity.

The old idea which constituted them the sole agents for the importation of necessaries for nutrition, is quickly shown to be untenable by comparative anatomy. We cannot dissect out an animal's lymphatic system, and then see whether he will absorb alimentary matters without it; but nature can do so, and exhibits to us in the class of invertebrata, animals digesting and absorbing all things required for the growth of their bodies without these vessels in any form in their intestines.

The longer we live, the more are the lymphatics deprived of their honours. Of late the most recent experimenter on this subject, Dr. Bernard, would take away from them altogether the reputed conveyance of albumen, and merely make them joint carriers with the bloodvessels of fat. He would deny also their having anything to do with the taking up of sugar. In fact, he views the chyle as simply the lymph formed by the destructive assimilation of the intestinal tube without any (except accidental) additions of nitrogenous compounds from the food, but holding in suspension a quantity of molecular fat—in short, an emulsion of oil in ordinary lymph. This is indeed reducing their importance to a minimum, and further experiments by other hands, and more deliberation on what they seem to show by other heads, is requisite before we build on this foundation.

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* Lehmann's *Phys. Chemie*, vol. ii., p. 284. Bidder and Schmidt, *Verdauungssäfte*, p. 286.

Dr. Bernard's paper in the *Comptes Rendus de l'Académie des Sciences* states his views and the reasons for them so succinctly, that it is worth transcribing here.

"There has been no particular name given to the nutritive matters which are carried from the intestines towards the liver with the blood of the vena portæ, although the special designation of *chyle* has been assigned to the products which are absorbed by the lymphatic system.

"The chylous-lymphatic vessels, that is to say those which have the property of absorbing fat in a state of emulsion, belong exclusively to the small intestine. They have been called also *lacteals*, for the very reason that during digestion they often contain an emulsion resembling *milk*, which fills them and renders them extremely visible. It is this latter circumstance which allows of the discovery of these vessels, and which beyond all doubt has caused the attribution to them of their part in the absorption of aliments; but this part has never been clearly made out, and there is nothing, as I hope to prove, to justify the extreme importance which physiologists have long attributed to the chyle, by viewing this liquid as the definitive result of digestion, and as a sort of quintessence of all the food together.

"The end which I propose to myself in this paper, is to fix by direct experiments the nature of the nutritive principles which are absorbed and borne exclusively by the chylous vessels. These researches have appeared to me valuable for fixing the precise signification of the word *chyle*, and for determining if there really are any alimentary substances which absolutely escape venous absorption, and consequently arrive at the blood in the lungs without passing through the liver.

"1st. *Of the Absorption of Sugar by the Chylous Vessels.*—Saccharine matter is absorbed in the intestine, sometimes in the state of glucose, sometimes as cane sugar.* Now when I introduced into the stomach of various mammals (dogs, cats or rabbits) great quantities of cane sugar, I have found this alimentary principle again in the blood of the vena portæ; but when the chyle from the thoracic duct of the same animals was collected under the same circumstances, I have never met with the cane sugar there.† So that proof is afforded by this experiment, which I have repeated many times, of the singular fact that sugar is not absorbed in a demonstrable manner by the chylous apparatus.

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* The acid of the gastric juice, as shown elsewhere, may transform a small quantity of cane sugar into glucose, but in the case of the cane sugar being abundant in quantity, the greater portion is absorbed without undergoing any modification.

† Except traces of grape sugar coming from the lymphatics of the liver.

"After what has gone before, then, it must be acknowledged that sugar is absorbed by the vena portæ exclusively, and consequently admitted that saccharine matters, before their conveyance to the lungs, necessarily traverse the liver. It can moreover be demonstrated by decisive experiments, that the passage of cane sugar through the hepatic tissue causes it to undergo a modification of the greatest importance in a physiological point of view. In fact if there be injected into the general venous system of a dog, by any vein on the surface of the body, a solution of two or three grammes of cane sugar, it will be found that, so far from being assimilated, this substance is thrown off almost immediately by the urinary secretion; if on the contrary this injection is made by a branch of the portal vein, so that the saccharine matter is forced to enter the liver, before it arrives at the general venous system, it may be proved that the sugar is not eliminated, that it remains, and becomes assimilated with the blood, precisely as happens when its absorption is brought about in the course of the normal process of digestion. We can now well understand how that the absorption of sugar by the portal system should be a necessary condition of its assimilation; for if its conveyance were entrusted to the chylous vessels (lacteals), the saccharine principle would be abstracted from the influence of the liver, and diverted directly into the general venous system, exactly as takes place when one injects it by the jugular vein.

"2nd. *Of the Absorption of Albumen by the Chylous Vessels.*—No observer has proved, I think, rigorously, that the chyle contains an excess of albumen in animals which are fed exclusively on this substance. It would be however next to impossible to conclude, on these results alone, that albuminous matter is not absorbed by the lacteals; for this determination of the quantity of albumen according to different modes of feeding, must be excessively difficult, because the blood and the lymph contain already a large proportion of this principle. I have thought that some physiological argument of a more decisive character might be brought to bear on the solution of this question, if proof could be got that for assimilation the albumen, like cane sugar, was obliged to pass through the liver. In fact, when you inject into the jugular vein of a dog or rabbit a little white of egg diffused through water,° you can show that in a little time afterwards the urine becomes albuminous. This experiment is interesting, as showing that the albumen of white of egg is probably not identical with the albumen of the blood, and that it must, before it is appropriated by the organism, receive some previous modification. But passing through the tissue of the liver is enough to effect the modification which seems necessary to the assimilation of albuminous matter; for if you

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° Without this precaution the white of egg would be too tenacious, and would cause the animal's death by sticking in the lungs, as M. Magendie has shown.

inject it by the vena portæ, it remains in the blood, and does not reappear in the urinary excretion. These experiments tend clearly to show that albumen is absorbed exclusively by the vena portæ; for if this substance were carried into the subclavian vein by the thoracic duct, it would be introduced directly into the general venous circulation, and would be placed in precisely the same circumstances as if injected by the jugular vein, as just now described.

"3rd. *Of the Absorption of Fat by the Chylous Vessels.*—In mammals fatty matters are absorbed very evidently by the chylous vessels, and emptied into the blood by the thoracic duct. Chemical analysis and microscopic inspection of the contents of the chylous apparatus leave no doubt on this point. In a previous paper I have shown, like M. Magendie and other physiologists, that the neutral fatty matters of the food, in order to become fit for entrance into the chylous vessels, must have previously undergone the emulsive influence of the pancreatic juice, so that the absorption of fat cannot commence in the small intestine till after the opening of the pancreatic fluid into it, whilst albumen and sugar might have been already absorbed in the stomach. It is known that as soon as fat in a state of emulsion enters the chylous vessels, their appearance completely changes; instead of remaining transparent, like the other lymphatics in the body, their contents take on a milk-white hue, quite characteristic; and, thanks to the transparency of the vessels, you can perfectly well follow with your eyes the passage of the fatty matter from the intestine right into the left subclavian vein, into which it is emptied by the thoracic duct.

"It might be supposed, according to the preceding statement, that in order to remain in the blood and to be assimilated, fatty matters have no need to pass through the liver; and such in truth is the fact. I have very often injected into the jugular vein, in large quantities too, various fatty substances (butter, oil, lard), which I had previously made into an emulsion with pancreatic juice obtained from dogs, and after these injections I never once have seen the urine contain fat and become chylous.

"It would seem then that we must distinguish the products of digestion into two groups, according to their mode of absorption: 1st. Saccharine and albuminous matters absorbed exclusively by the vena portæ, and necessarily passing through the liver before arriving at the lung: 2nd. Fatty substances absorbed by the chylous vessels, and getting into the general venous system and into the lungs without first going through the liver.

"This latter proposition must not be taken in such an absolute sense as the first, for microscopical examination and experiments show that fat is absorbed at the same time by the vena portæ and by the system of chylous vessels. When the contents of the thoracic duct and the blood of the vena portæ are examined in a dog during digestion of fatty matter, these two liquids are seen to contain nearly equal quantities of fat in a state of emulsion; only it is much less visible in the blood, by reason of its colour. But if the clot is allowed to form and the serum to separate, the latter is shown to be rendered opaque and whitish, like milk, by the fatty substance in a state of emulsion which it holds in suspension.

"Moreover, if in mammals one might attribute to the chylous system a very evident part in the absorption of fat, it is not the same with many birds, for example, where it is well known to be impossible to prove the existence of any sort of chylous lymphatics, that is to say of white lymphatic vessels charged with suspended fat. I have crammed pigeons, fowls, hawks, &c., with fat, and on killing the animals during active digestion, I have never found the least whitish or chylish appearance in their intestinal lymphatics, whilst the blood of the vena portæ contained quantities of fatty matter in a state of emulsion.

"In fine, there is but one alimentary substance (fat) for the absorption of which one can claim the influence in an obvious manner of the chylous lymphatic system; and again this function, which is shared with the vena portæ in mammals, is completely annulled in a great number of animals who nevertheless digest and absorb fatty substances very well. Whence I conclude that the chyle cannot be viewed as a liquid containing in itself all the nutritive principles of the food."*

To these experiments, as far at least as regards sugar, Dr. Lehmann offers the following objections. He thinks that the sugar found in the vena portæ by Dr. Bernard had regurgitated from the liver, and in support of that idea quotes a private communication from the experimenter, stating that when the blood was drawn by making a small opening, in which case regurgitation would not occur, the sugar was not discovered. He made also the following counter-experiments on three horses:—The animals were fed every two hours with a mixture of equal parts of cooked and raw potato-starch made up into balls with about a twelfth of rye bran; of this they took from two to three kilogrammes, equivalent to about a kilogramme of sugar, per diem. This diet was continued for three days; and on the third day the amount of starch contained in the excrement voided in twenty-four hours, and an estimate made of the carbonic acid developed by fermentation. The animal was destroyed about an hour and a half after the last meal, the contents of the bowels, the chyle, and the portal blood examined with a view to the discovery of sugar.

Horse No. 1 consumed in the last twenty-four hours 1584 grammes of dry starch; in the fæces were found 234 grammes, so that the animal had absorbed in twenty-four hours 1350 grammes of starch, in the shape of 1500 grammes of sugar.

Horse No. 2 consumed 1236·3 grammes of starch; there was found in the fæces 321·5 grammes, so that it absorbed 1016·4 grammes of sugar.

Horse No. 3 consumed 1871·8 grammes of starch; there was found in the fæces 413·2 grammes, so that it absorbed 1620·6 grammes of sugar.

So that in these three animals, if the starch were all turned into sugar, 1382 grammes of sugar were formed and transferred into the blood and chylous vessels. As they were fed at the short interval of two hours, we may conclude that in one hour 57½ grammes and in one minute nearly 1 gramme became blood or chyle. Now neither in portal veins nor in lacteals is the motion too quick to prevent one's catching some of the absorbed sugar on its way, so that if it were taken up in that form, it might be expected to be found in the portal blood or chyle. But in both there was in every instance only a trace, and in some none at all to be found.*

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* *Comptes Rendus de l'Académie des Sciences*, vol. xxxi., p. 798.

Dr. Bernard's argument, as supported by his experiments is in short as follows:—

Albumen and sugar require modification before they enter the general circulation;—

The liver is capable of effecting this modification;—

Therefore, the liver alone (or almost alone) effects it.

The fallacy lies in the possibility that the required changes may be effected by other means also; viz., by the digestive juices in the first place; or secondly, by the intestinal glands during the passage of these alimentary substances through them. Dr. Lehmann's investigations seem to show that the first of these contingencies occurs.

In fine, our present state of knowledge allows us to look upon the bloodvessels and lymphatics as colleagues in the duty of absorption, and as both apparently capable of executing each department in a more or less perfect manner. But the limits of the office of each under ordinary, and still more under varied circumstances, are as yet undefined.

The question before alluded to, of the quantity of the chyle, is one closely allied to its rapidity of progress. Whereas in the bloodvessels endosmosis, as before shown, is helped forward by the motion of the fluid, in the lacteals on the other hand endosmosis has to be the originator itself of the motion. No doubt it is a most powerful one, as is shown by the well-known experiments of Dr. Daubeny and others on the forces exerted by the rising sap in plants; yet is it exceedingly slow, and scarce fit to be named in the same breath as that of the blood.

This mention of the motion of the chyle appears to give a fair opportunity of introducing a matter of great interest, and apparently likely in a short time to prove of still greater—I refer to the recently discovered *muscles of the villi*, inasmuch as it seems not improbable that they in some degree contribute to help forward the sluggish current of the lacteals.

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* Lehmann's *Physiol. Chemie*, vol. iii., pp. 800—804.

That the villi contract and relax alternately has been known about a dozen years. The movement is compared by Messrs. Gruby and Delafond* to that of intestinal worms, consisting of elongations, shortenings and lateral motions. And the same writers also suppose that the circulation of the portal vein is helped by these motions; so that the suggestion made above as to their influence over the lymphatics, is merely an expansion of the same idea. Quite lately Dr. Brücke, at Vienna, has confirmed these observations as regards the shortening and elongating movements, and does not deny the lateral ones also, though he has himself not seen them. But what renders his investigations of prime importance is, that he has discovered *their origin*. He finds in each villus rows of *muscular fibres*, of the same sort as those which form the muscles surrounding the intestinal tubes, and therefore presumably following the same laws. He has in short confirmed the truth of their motion, by showing that they have wherewithal to move.

"The muscular fibres of the villi, first seen by Brücke, are capable of perfect demonstration, according to my experience in man, in many mammals, and also in birds (the white owl and the goose), but are in certain cases however not to be proved. In men, for instance, I have many a time sought them in vain where the parenchyma of particular individuals was very rich in nuclei, fat molecules, or perhaps morbid pigment. To see them, villi must be taken which are as normal as possible, and wanting in the aforesaid morphic elements; and they must be looked for under water, both in the perfect condition and when torn to pieces, as well as with the addition of dilute acetic and muriatic acids. Then there may be easily seen in the interior a long striated substance, next to and around a central cord, which is usually dark and filled with fat molecules. This striped substance shows itself here and there as consisting of narrow, slightly wavy fibres, thickest in the middle, and presents very characteristic long narrow nuclei."†

With his usual caution, however, the Professor does not commit himself to say absolutely that these are smooth muscular fibres, though he describes them exactly as such.

The importance which, rightfully or wrongfully but certainly with insufficient proof, has been attached to the lymphatic lacteal vessels of the small intestines, has too much drawn away atten-

* *Comptes Rendus de l'Académie des Sciences*, vol. xvi. p. 1195.

† Kölliker's *Mikros. Anat.* vol. ii. 2, p. 158.

tion from the bloodvessels. Yet these are familiar enough to most of us, forming an indubitable plexus, really something like network, around each villus, and furnishing an irresistibly elegant subject for an engraving in almost all books of anatomy and physiology. They completely surround the solitary lacteal in the centre of the villus, and when in full vigour cannot but cut off many of the supplies which otherwise perhaps might come to it. The *vis à tergo* which circulates the blood through the rest of the system, has full play on them through the arteries, and a ready path is afforded by them to the liver for those food-stuffs which we have just seen that organ is fully capable of making a good use of.

SECTION III.—*Glands of the Small Intestines.*

What is a gland? The previous pages of this volume have had occasion to use the word only in its application to certain definitely bounded organs, whose office is to form from the blood special compounds, and throw them outside the solid tissue of the body, sometimes with the intention of their being partly, and sometimes with the intention of their being entirely, taken up again. In order to throw off their secretion, all these must obviously have an *excretory duct.*

Now some physiologists, among whom may be mentioned Mr. Goodsir, have made this excretory duct an essential characteristic of glands, and refused to sanction the popular language which assigns the same name to several other bodies of like appearance and of analogous office in most points of view, but wanting this distinction. Among others thus excluded are the thyroid and thymus glands, the lymphatic, and (what we are more especially alluding to) the mesenteric, solitary, and Peyerian glands of the small intestine.

Not to mention the inconvenience of disturbing established nomenclature, it really does not appear that the distinction thus created is a philosophical one. For looking in its true light at a secretion which is again either wholly or partially to be absorbed, it is a stage in a circulation, part of a chain of modifications in a continually recurring fluid. Now, it is not denied that the office of the above-named *soi-disant* "glandular" organs is to effect certain alterations in the fluids which pass through them, to wit, the blood and lymph. They therefore are, equally with the others, a stage in the circle, but a stage more complete in itself—more independent so to say—for it combines both secretion and reabsorption. The only difference is, that in one class a part of the circulation goes on outside the solid tissue of the body, and in the other class inside, and that in the former therefore there is an opportunity given for some substances being completely separated and rejected—for the purely excretory duties of glands. When we take this broadly philosophical and practical view of the subject, it seems more useful and important to unite under a common name organs so connected in office, than to divide them asunder. The classification of glands most suggestive for physiological purposes would be according to their resemblances rather than their differences, as thus:

1st. Purely EXCRETORY glands, of which none of the secretion once formed is taken up again, as far as we know; such as the *kidneys*, *prostate*—where it is continuous—the *testicles mammæ*—where it is occasional; or to adopt a less accidental division, such as the *kidneys*—where it is excretory, as regards the whole species—the *testicles*, &c., where it is so only as regards the individual.

2ndly. Purely ALTERATIVE ductless glands, which have no passage to the open air, and cannot therefore excrete at all; such as the *suprarenal capsules*, *spleen*, *thymus* and *thyroid*, *mesenteric*, *solitary*, and *Peyerian* glands.

3rdly. Glands of MIXED office, partly excretory and partly alterative, which must necessarily have open ducts; such as the *salivary*, *œsophageal*, *stomach*, *pancreatic*, *duodenal*, *Brunner's*, *Lieberkühn's* glands,—of which the excretory office is conjectural, and the alterative obvious; the *liver*, *lungs*—where there is a considerable obvious amount of excretion.

The first class have but little connexion with the subject of digestion. In the third class come all those we have hitherto passed in review in the alimentary canal, and others which will shortly be mentioned. The easiest transition from the subject we have been last considering, will be to the second class, because in it are included those glands whose connexion with the lymphatic vessels has always been acknowledged, and others which recent observation tends to place in the same category, viz.

The Mesenteric, Solitary, and Peyerian Glands.—In its road from the rootlets of the lacteals in the villi to the thoracic duct, the chyle undergoes considerable change. Part of this change is discernible by the eye, that is to say, it consists of alterations of shape and appearance in the solid, organic, or morphic elements of the fluid. In fact it appears that whilst at the commencement of the lymphatic system only bodies similar to young cells are discerned, in the thoracic duct fully developed cytoblasts are to be found. The growth of perfect cells from nuclei seems to take place in these vessels.

Professor Kölliker, in a paper published in 1846, says that at the commencement of the vessels only, and never in the thoracic duct, has he found what he thinks to be *young cells*, namely collections of bodies, some of which are free nuclei, some nuclei surrounded by a greater or less number of fine nucleoli, while some have a very delicate membrane scarce raised from the nucleus. The further development of the lymph-cells consists of a great increase of their number in the thoracic duct, their enlargement, and the thickening and strengthening of the cell wall; while at the same time fluid and new nuclei are produced in the space between nucleus and membrane. To follow the cells into the blood is not within the limits of the present subject.*

Chemically viewed, the changes in the chyle consist in a great increase in quantity, or perhaps an entirely new formation of both fibrin and albumen, after passing through the mesenteric glands. The experiments of Tiedemann and Gmelin show that both principles exist in exceedingly small amount in the portion of the lymphatic system anterior to these glands, and form a distinguishing feature in its contents in the subsequent passage to the thoracic duct. So that in these important nutriments the chyle is richer the farther it gets from the intestinal canal; a circumstance which by itself seems sufficient to destroy the prestige it has gained as a supply of nutrition.

In one article alone does it become impoverished in its passage—namely, fat. The small lacteals are much fuller of oil molecules than the great receptacle of the thoracic duct. It is evidently in some manner expended on the road, and there are two ways in which it may be so expended—one revealed to us by the microscope, and one by the laboratory. It may go to assist in the cell growth which we have just described as taking place, or it may be saponified by the alkalies present, and so form the great amount of neutralized fatty acids poured into the subclavian vein.*

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* *Kölliker* in Henle's *Zeitschrift für Med.*, vol. iv., p. 142.

The patches of glandular matter, called "the patches of Peyer," have always been a puzzle to physiologists. They evidently secreted nothing, as they had no outlet; and their principal interest seemed to consist in a tendency to become ulcerated in disease. But in 1849 Dr. Brücke, of Vienna, as he was trying to inject with reddened oil of turpentine the lacteals of a kitten, accidentally discovered a connexion between these Peyerian patches and the chylous lymphatic system. In one part only a few vessels became filled with the coloured injection, which led from the Peyerian patches through the mesentery right to the thoracic duct. This induced a strong suspicion of the connexion, which further investigation and an observation of an apparent likeness in anatomical structure to acknowledged lymphatic glands confirmed in the author's mind. He has not, however, brought forward any proof stronger than his first experiment. The matter is still *sub judice*, and we expect with much interest the inquiry promised by Professor Kölliker.

The little we do know of Peyer's patches certainly favours the expectation that the connexion foretold by Dr. Brücke, or rather some intimate connexion with absorption, will be found true. In the first place, they are found to swell up during the digestion of substances in the small intestine. Then there come from the situation of the patches more lacteals than from any other place. It is fair, too, for pathology to repay some of the benefits it is daily receiving from physiology by the remark that, in disease, the changes of the patches and of the mesenteric glands usually run together, and are both associated with the destruction of the functions of the mucous membrane.

But it may be remarked, that a connexion with absorption does not necessarily imply an anatomical connexion with the lymphatic system. A great plexus of bloodvessels runs through all these closed ductless glands, and there is nothing to stand in the way of the possibility that it may be to effect changes in their contents, or perhaps to transact some mutual interchange of their contents with those of the lymphatics, that the organs in question are here placed.*

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* Lehmann, *Physiol. Chemie*, vol. ii., p. 281.

I must confess that it seems as if a little violence was done to the subject of the morphological formation of blood by introducing it as an appendix to absorption, but I do not see how else it could be brought in, except by giving it a separate chapter. I am unwilling to do that, because there is not enough known of the matter yet to make much reflection about it useful to a medical man. And really, when we consider how these glands stand on the absorbent vessels, there is nothing artificial in viewing them as a part of the same. They stand, in fact, in the relation that coining does to the importation of gold; they impress the form on what is otherwise fit for future use. To have made a separate subject of this would have involved a review of the spleen, thymus, thyroid, &c., and much obscure matter, less profitable (alas!) at present than interesting; and it would not have been easy then to stop without invading nutrition, and in fact the whole of physiology. The system of nature is such a continuous chain of events, that stopping at any point always involves either a little rebound of the argument, or a little overstepping of fixed limits.

Secreting Glands of the Small Intestines.

It must be remembered that here, as before, we are no further concerned with secretion than as a previous stage of the great circulation, of water especially; of which circulation a further stage constitutes absorption in its narrow sense. We are not therefore to speak of the excretive or solvent powers of the fluids mentioned. The quantity of fluid poured out by the secreting glands which lie immediately under the mucous membrane of the small intestines, the glands of Lieberkühn and Brunner, is not great: it is reckoned by Drs. Bidder and

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* Kölliker's *Mikrosk. Anat.*, vol. ii. 2, pp. 188—194.

Schmidt at about half a pound a day in the human subject. The glands of Brunner correspond with the salivary glands in anatomical structure, and the glands of Lieberkühn with the glove-finger-shaped glands of the stomach (without the peculiar stomach cells, of course), so that we should *expect* that analogous duties are performed in each case, though in truth we have no *proof* of the fact. We should suppose the former were intended to pour a considerable amount of aqueous secretion on a given spot, and the latter more gently to irrigate the surface. This remark of course has reference to them only in respect of the water furnished, and not to their solvent powers, which it would involve future repetition to allude to here.

It would seem as if the business of absorption was in this mucous surface so paramount, that there might be danger of interfering with it by making the same place an absorbent and a highly secreting surface at the same time. It is doubtful whether other mucous membranes have at all the power which we here find, of taking up oil and other matters insoluble in water, and one may easily imagine the difficulty of that power being consistent with much aqueous secretion.

Our idea of the intention of the small intestine as a place specially set apart for absorption, is strengthened by the care which is displayed in keeping at the upper part of the canal the outlet of the great visceral glands which contribute so largely to the passage outwards of the circulating water, the liver and pancreas. If these are reckoned as parts of the small intestine, then indeed its contribution to the outward passage is very great; the former furnishes from three to four pounds a day, of which 95 per cent. is water, and the latter half a pound with 90 per cent. of water.

In the upper part of the small intestine, then, the outward-bound character of the aqueous circulation may be viewed as still predominant, but in the lower part it is without question the homeward-bound. The water has hitherto been going forth into the world, bearing only ballast and means for gathering wealth, and now is returning back laden with abundance.

SECTION IV.—*The Intestinal Juice.*

Solution *in* the intestines and solution *by* the intestines are very distinct things. The former implies the action which is caused by the united secretions poured into the canal, commencing immediately after their ducts open into the common road, and continued for an indefinite distance, perhaps for the whole extent of the duration in the body of the substances submitted to it. The latter refers to the supplementary influence exerted by the fluid formed by the membranous walls themselves, or of the glands imbedded in them.

First of all it must be remarked that the quantity of this latter fluid is very small, and that it is not uniform throughout the parts from whence it derives its name. In animals recently killed, after being deprived of food for a day and night, the upper part of the small intestine has its mucous membrane covered with a semi-fluid yellow slime, in which there were seen by Drs. Bidder and Schmidt under the microscope, epithelial cells, whole and in fragments, whilst in the lower part of the ileum and in the large intestine (in which even in starving animals a considerable quantity of fæces is to be found) the interior of the canal was only just moist. Of these exhalations the action on litmus paper was always alkaline, though in truth in many different degrees, or irregularly various.

If the animals had been recently fed before death, the secretion was more copious, but never in Drs. Bidder and Schmidt's experience sufficient to allow of analysis.

An acid reaction was often in carnivorous, and always in graminivorous animals, evident in the *contents* of the intestinal canal, and by no means confined to the cæcum. Yet this did not prevent the *walls* in each locality being alkaline throughout.

The opening an artificial fistula into the ileum enabled Drs. Bidder and Schmidt afterwards to obtain enough intestinal juice for analysis; but there is nothing in that analysis which appears of physiological importance. Their estimate of the quantity depends on the assumed amount of the bile and pancreatic juice being deducted from the total fluid, and is therefore open to all the fallacies of a calculation from doubtful data.

The fact of chief importance which comes out of this series of experiments is the following: after drinking it was observed that not only the quantity of intestinal juice was increased, but that this augmentation of secretion was due as much to a greater amount of solids being poured out, as of fluids; it was not merely the usual secretion added to by the water taken in, but a more copious formation of it with its ordinary proportions of ingredients. This seems to show that the water was not merely carried along the cavity of the alimentary canal, but absorbed by the stomach, and thrown out again by the intestinal mucous membrane, carrying with it the ordinary outgoing elements.

Section V.—*Intestinal Digestion.*

In order to test the digestive power of the small intestine, Dr. Frerichs took out through the abdominal walls of cats or dogs a coil of gut, and tying it above and below, inserted some coagulated albumen into the closed bag thus formed, and returned it into the abdomen. He was unsuccessful in obtaining any proof of solvent action, as were also Drs. Bidder and Schmidt, when they repeated the experiment in the same manner.[*]

This failure they attribute to the small quantity in which the secretion is formed, when such a method of procedure is adopted:—"scarce a couple of drops could be collected." They tried therefore another plan: they placed a ligature only *above* the place where the gut was to be tested, so as to cut off the influx of gastric juice. Then waiting for a few hours, till all that was already in the bowels was absorbed or passed onwards, they introduced the albumen or muscular fibre in little bags into the alimentary canal, through an artificial opening made in the ileum or jejunum. The bags were allowed to be carried forward by the peristaltic motion unrestrictedly for from six to fourteen hours, when the animals were slain. Thus all went on the natural way, except the passage downwards of the digestive solvents from above, and perhaps the free action of the peristaltic movements. At all events, the secretion stood a much better chance of being natural in this way than the other.

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[*] Bidder and Schmidt. *Die Verdauungssäfte Fünfter Abschnitt:* (*Von Darmsaft.*)

After the death of the animal the test bags were found at a great variety of distances from the hole where they had been inserted; some had scarce moved from it, and some had been carried down even as far as the cæcum. There was great variety also in the way in which the nervous system was affected; sometimes the operation was followed by great prostration, but more commonly the ordinary cheerfulness and comfort was unimpaired. These phenomena however appeared to have no relation to one another; the bags had gone on just as far in the prostrated subjects as in those which kept up their spirits. In every case there was a considerable loss of substance in the coagulated white of egg or flesh meat in the bags; but this loss of substance was various in degree, and did not at all depend upon either of the above-mentioned circumstances. It was sometimes most marked in those instances where the bags had stirred but little, while in one which had travelled into the cæcum, the white of egg was so broken up and dissolved that it could not be weighed. Two bags were used in each case, one filled with white of egg, and the other with flesh; sometimes the former, sometimes the latter was most dissolved. So various was the per-centage of loss of weight, ranging in fact from 18 to 95 per cent. of the solid parts of the matters used, that an average would be a misrepresentation of the truth; and we must content ourselves with the knowledge that such solution of albuminoid matters takes place in the small intestine, and that it is not likely to dissolve less than 18 per cent. of the quantity submitted to it in the ordinary duration of digestion.

Now in many of these experiments, in order to disturb as little as possible the abdominal viscera, the pancreas and liver were allowed to discharge their secretions as usual into the alimentary canal; but as we have already seen such good reason for believing that they have no influence at all over albumen, their influence may be reckoned as simply null. A further proof of this may be found in the fact that a solution was effected no quicker and to no greater extent when these secretions were present than when they were absent.

As in the case of the saliva and gastric juice, solution was effected by the intestinal secretion on albumen in the test tube as well as the bowel. It was effected too in a more even manner, with less variations in the per-centage than inside the body. Here from thirty to fifty per cent. of the substance was dissolved in six hours, with great regularity, while in the living bowel the greatest variety occurred, as has been before stated.

Outside the body, as inside, the admixture of bile or pancreatic juice seemed to make no difference in the solvent properties of the intestinal ferment. So then in this power it possesses under *many*, perhaps under *normal* circumstances, one decided advantage over gastric juice, which it may be remembered is wholly checked in its operation by bile or any alkaline fluid. Indeed, an alkaline condition is the proper state of activity of this ferment, as acidity is for that of the stomach; and one regrets that the Derpt Professors did not carry their investigations a little further, and notice whether or not acidity would impede its action, as alkalinity does that of its colleague.

In addition to dissolving albumen, the intestinal juice possesses also the power, in common with the saliva and pancreatic fluid, of converting starch into sugar; indeed, its action in such respect is rated by Drs. Bidder and Schmidt as being nearly as high as that of the latter. This was tested by tying up some boiled starch in a coil of bowel, and returning it to the abdominal cavity. On killing the animal three hours afterwards, none of the usual blue colour was elicited by iodine, but a considerable quantity of sugar was made evident by Trommer's test.

Of the colon, the secretion is so small in amount, indeed no more than is just sufficient to keep the membrane moist, that it is not likely any solvent power of important extent can be exercised by it. Experiments on living animals in the Derpt laboratory proved nothing respecting its functions, either affirmatively or negatively; agreeing in this with an observation made by Dr. Steinhäuser on a patient with an ulcerated fistulous opening. Pieces of meat and coagulated white of egg were introduced through this into the large intestine, and were afterwards found to be carried off with the fæces entirely unaltered in form or consistence. For all physiological purposes we may conclude that in health the solvent action of the intestines ceases with the valve of Bauhin.

I said "*for physiological purposes,*" because though in a state of health we may be very well satisfied with the chances of solution which the food has had by the time it has got to the above named goal, in disease we occasionally want something more. Cases occur where nourishment is not able to be furnished by the ordinary route in sufficient quantity to support life, and it becomes a vital question whether we are of any use when we give the colon the opportunity of absorbing it. Medical experience certainly seems to answer in the affirmative; nourishment in the shape of soups, milk, &c., when given in enemata, is constantly found to give fresh vigour to patients who are unable to retain it on the stomach; and medical men cannot help therefore attributing to the colon some power of converting into soluble chyme the albuminoid matters contained in these aliments. Whether this power be possessed in health or not is uncertain—perhaps it is one of those latent, rather than dormant, properties called out only under the impulse of need—perhaps it consists in the trickling downwards of the unused ferments from the upper parts of the alimentary canal. However it is to be explained, it is a phenomenon of the highest practical importance, and which we should be glad to see made the subject of scientific investigation. Who that has a patient thus afflicted would not be glad to feel assured that he was acting on firm physiological data in using the traditionary means of relief?—who would not be anxious to learn what forms of nourishment are most likely to be digested in this part?

Is the intestinal digestion of albuminoid food merely a dormant power possessed by these parts in obedience to certain laws of nature, but unapplied to any necessary purpose? In fact, is the stomach quite sufficient for the digestion of the substances proper for it, or is their future submission to a solvent important to the animal economy?

Now in dogs it certainly does appear that a meat meal, not exceeding what reason would sanction, *may* be entirely converted into " Peptone" without going further than the pylorus, and as a rule *is* so converted. But even in those rapidly digesting animals how often it must happen that the stomach is temporarily overloaded, or violent exercise taken after eating, and then the organ is unable to do its full work, and much unaltered muscular fibre, &c., passes into the intestines. This is an experiment easily tried—feed a dog on meat, and work him hard immediately, and you will quickly find liquid fæces excreted with undigested morsels of muscular fibre in them. How valuable to him in such frequent occurrences must be the intestinal digestion!

But in man its value is still more marked. From the observations of Dr. Schröder on a healthy patient with gastric fistula, it appears very doubtful if even under the most favourable circumstances the human stomach can entirely disintegrate all the muscular fibre of an ordinary meal;* and often and often man's wilfulness must place him in situations where the organ cannot even do its natural work. It seems highly probable that intestinal digestion is of great economical importance to our race.

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* *Succi gastrici humani vis digestiva*, p. 23, &c.

CHAPTER VI.

THE PANCREAS.

THE structure of the pancreas is so similar to that of the salivary glands, that Professor Kölliker does not think it requisite to give any separate description. We will proceed therefore straight to the

PANCREATIC JUICE.

SECTION I.—*Physical Characters.*

The description given by Drs. Bidder and Schmidt of the pancreatic juice of the dog is, that it is a perfectly clear, transparent, colourless liquid, of a sticky, tenacious consistence, of the specific gravity 1·03, without any organic elements visible in it. It has a strong alkaline reaction, coagulates by the addition of alcohol into a milk-white mass, which is deposited in thick white flocks, floating in a transparent, highly-alkaline solution of alcohol. If the flocks are separated, they are found capable of being dissolved again in water, forming a fluid of about the consistence of the original secretion. The principal olid constituent of the precipitate is lime; of the transparent part the dried residue consists chiefly of an albuminoid subtance.

Quantitative analysis showed—

of water	900·76	parts
of solid matter	99·24	"

Of these solid matters there were—

of organic substance . . .	90·38	parts
of inorganic substance . .	8·86	"

It seems however that the water, as in most secretions, varies in its proportion, for Dr. Frerich's analysis gives only 16·2 instead of 99·2 parts in a thousand.

The most important facts in the analysis are—

1. That there is a large amount of solid matter dissolved in a transparent fluid.

2. That of this solid matter $\frac{9}{10}$ is of an albuminoid nature, like the ferment of the saliva and of the gastric juice.

SECTION II.—*Quantity.*

In no other observations on the pancreatic juice, besides those made at the Derpt laboratory, are the weights of the animals given, so that they give us no assistance in estimating the comparative daily flow in other cases.

There is moreover a difficulty in ascertaining the full amount of the secretion in dogs, arising from the additional small upper duct, which is too short to be tied conveniently. By measuring however the quantity passed through a canula secured in the larger duct, and from a comparison of the area of the two reckoning the probable flow of fluid through the smaller, Drs. Bidder and Schmidt found that the dog operated upon formed 1·4 gramme of juice for each kilogramme of its weight in the twenty-four hours. They reckon also that this was only the half of the quantity usually made under ordinary circumstances. If these data are allowed, the probable proportion for a man of ten stone to secrete in twenty-four hours is 150 grammes, or about seven ounces avoirdupois.

The influence of food over the pancreas is marked by the substance of the gland being of a faded yellow colour in animals killed while hungry, while two hours after a meal it is tumid and purple. The secretion too, which in the fasting state flows in sluggish drops from a canula inserted into the duct, will run even in a continuous stream after nourishment has been taken.

SECTION III.—*Ascertained Physiological Action.*

It is allowed on all hands that this fluid has the property of converting starch into sugar in the same manner as the saliva.

Dr. Bidder says that the conversion effected by the substance of the gland is even quicker than in the case of the salivary organs. A reference to the table given at page 35, shows the difference that was observed. The cause of the difference may be supposed to lie in the peculiarity there detailed, of the salivary ferment being in activity only when the secretions of several glands are mixed, whereas the pancreas contains in itself all that is required for full action. A very considerable time does not destroy this property; after twenty-four hours' separation from the animal, the juice was found as active as ever; nor does a temperature a good deal below that of the body—for it was left at 64° Fahrenheit without injury.

It is remarkable, too, that contrary to what was observed in the case of the salivary ferment, its conversion of starch was in no degree prevented by the addition of gastric juice or bile.

Besides its share in the general endosmotic circulation in proportion to its quantity, I do not think any further action can as yet be attributed to the pancreatic juice.

It would not however be right to pass over without notice certain presumed powers of this secretion, which have of late attracted a considerable share of attention. I refer principally to its action on fat.

In 1849 Dr. Claude Bernard published in the *Archives Générales de Médicine* some observations on the pancreatic juice, in which he attributed to it,—first, *a peculiar emulsive power*, greater than any other animal fluid, so that fat remained suspended in it in a finely divided state longer than in any of them; secondly, *a power of resolving neutral fat into an acid and a base;* and from hence concluded that it was the *chief, if not the only agent in the digestion of fatty substances;* an idea which further seemed to receive confirmation from direct experiment.

He grounded the first upon the observation that pancreatic juice, when shaken up out of the body with oil, preserved it in a suspended state for from fifteen to eighteen hours; whereas other animal fluids such as saliva, gastric juice, bile, serum of blood or of the cerebral cavities, allowed it to separate very quickly. Now as respects bile, Dr. Bidder says that the reason why it separated so quickly was because he did not take enough of the fluid, for when oil is mixed with a large excess of bile, it will remain in emulsion for a couple of days. And this excess of bile is certainly the nearest to the natural circumstances of the body, for the secretion of the liver far exceeds both the quantity of fat taken and the pancreatic juice. So that further inquiry is clearly required before we determine even that a higher emulsive power than that of other animal fluid, the quantities of each being equal, is possessed by pancreatic juice: still further, before we say that small as it is in amount, it yet exceeds the more copious secretions in that quality; and still further before we attribute to it the sole possession of the capability. The fact is, that if the emulsion of fat be necessary, other animal secretions seem quite as able to effect it as pancreatic juice.

The power of resolving fat into glycerine, and oleic, margaric or butyric acid, as the case may be, was presumed from the fact that when mixed with fresh butter it caused the rapid evolution of the odour of butyric acid and the reddening of litmus paper. This observation seems to be confirmed by Drs. Bidder and Schmidt,* and by their pupil Dr. Lenz, at least as far as the circumstance happening after two or three hours. The latter physiologist, not satisfied with the observation of it only in the test tube, endeavoured to carry his inquiries into the living body also. For this purpose healthy cats were fed with fresh butter, and the following triple series of experiments made:—

1. Some were killed at various times from six to fourteen hours after the meal. The chylous vessels and the thoracic duct were filled with milky chyle, but there was no trace of butyric acid in the alimentary canal or portal veins or gall-bladder.

2. After the animals had been kept from food for thirty-six hours, a ligature was tightly fixed round the pylorus to prevent the passage of gastric juice; then fluid butter was injected into the duodenum through a small hole, which was immediately fastened up, to prevent the escape of the contents of the bowels into the peritoneum, and the parts returned into the abdomen. When the creatures were killed from nine to eleven hours afterwards, there was plenty of butyric acid, with its peculiar smell and reddening power on litmus exhibited in the alimentary canal. It was not however to be found in the thoracic duct, portal veins or gall bladder.

3. Again the same experiments were repeated, with the variation of putting the first ligature *below* the entrance into the duodenum, of the pancreatic and gall ducts, so as to cut off the influence of all these secretions. In other cases the pancreatic duct was tied, and then butter injected, so as to try whether the decomposition of it could be effected simply by the warmth of the body. The animals were killed after from seven to twelve hours, and *in none was there any butyric acid to be found in the intestines.*†

These experiments seem to show that pancreatic juice really does seem to possess some power of decomposing neutral fat, but that when, as in the healthy condition, acid gastric juice is mixed with it, the property is lost. The absence too of butyric acid in the chylous vessels proves that fat is less digestible in this state than when neutral.

Further experiments outside the body seemed to show that gastric juice prevented the decomposition of oil just in the ratio of its acidity, and that neutral gastric juice does not prevent it at all.

Does not all this tend to the belief that when fat is decomposed into acid and base in the bowels, such decomposition is a form of indigestion?—that it arises from the imperfect secretion of gastric juice, its neutralization by catarrhal mucus, or some such morbid condition?—and that far from being necessary to digestion, it is an impediment to that process?

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* *Die Verdauungssäfte*, p. 241—259.

† Lenz, *De Adipis Concoctione et Absorptione*. Dorpati, 1850.

Dr. Bernard's conclusion as to the importance of the pancreas in the digestion of fat was confirmed by what he saw in rabbits. In that animal the ductus choledochus empties itself close to the pylorus, and the pancreatic secretion enters the duodenum eleven or twelve inches lower down, that part of the gut being singularly long for an animal so small. By feeding a rabbit on a meal of fatty substances after a previous fast, and killing the animal about four hours afterwards, it is easy to show (as I did in my Gulstonian Lectures, in 1850, at the College of Physicians[*]) the lacteals filled with fatty chyle after the junction of the pancreatic duct, while above that place they are not visible. Hence Dr. Bernard concluded that it was the pancreatic juice alone which caused the fat to be absorbable. The fallacy lies in the time at which the animals are killed after the meal. It appears that by four hours the food has so far passed down the gut, that the upper lacteals have passed onwards that which they had absorbed, and are again empty. If they are examined at an earlier period, the vessels will appear white above the pancreatic duct as well as below.

Another argument sometimes relied on as an additional reason for connecting the pancreas with the digestion of fat, is an association which has been attempted to be made out between disease of that organ and the discharge of fatty matters by the bowels. But disease of the pancreas uncomplicated with that of other viscera, so as to be anything like an *experimentum crucis*, and also fatty alvine discharges, are so rare that very little can be made of this argument. So rare indeed is the latter phenomenon, that a French physician, Dr. Moyse,[†] writing in 1852 specially on this subject, is compelled to quote those published by Dr. Bright in the *Medical-Chirurgical Transactions* for 1833, nearly twenty years before, with the addition of one new one only, and that from an American source. Then, with respect to those oft-cited cases recorded by Dr. Bright, I think the nature of the discharges would, perhaps, in the present day be placed in a different category than at the date of their occurrence. Most of course have been thrown away, but one example, which has been preserved with great care in the museum of the College of Physicians, turned out, when the museum was put to rights in 1850, not to be fat at all. In fact, microscopic examination showed it to be muscular fibre—a lump of meat washed white in its passage through the bowels of a dyspeptic patient.

The questions which arise out of this discussion are:—First, Is the resolution of fat into an acid and base requisite?—Secondly, Is emulsion, or extremely fine division, requisite? The first question has been already answered by the great probability of its being not only unnecessary, but hurtful. As regards the second, there is certainly nothing to induce us to reply in the affirmative. Experiments tried by Dr. Lenz (*opus citatum*, p. 43) prove that oil emulsioned as fine as possible with bile or any other slimy medium, still refuses *out of the body* to pass through animal membranes. It is to be regretted that pancreatic juice was not tried as a medium—had it been so, the argument would have been doubled in value. Still, as before said, we have no evidence of emulsion helping the matter at all.

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[*] "On Corpulence, or Excess of Fat in the Human Body," published in the *Lancet* of the same year.

[†] *Etude Historique et Critique sur les Fonctions et les Maladies du Pancreas.* Paris, 1852.

The most complete test of the influence of the pancrèatic juice in the absorption of fat, is a series of thirty experiments on cats made by Drs. Bidder and Schmidt. The pancreatic duct was tied, and in some cases the secretion allowed to be retained, in others carried off by canula. Thirty-six hours after the operation the animals commenced feeding on fat, and were nourished in this way a couple of days. At various times, from five to twelve hours, after the last meal, they were killed, and the lacteals examined. In all cases they were more or less filled with fatty chyle, and this absorption was observed to be in a direct ratio to the freedom of the membrane from inflammation. Where the latter phenomenon was exhibited, there the chylous vessels were transparent; where they were white with fat, there was no inflammation. In every case it was proved by examination that the pancreatic duct was so secured that none of the juice could have passed into the intestinal canal. Dr. Bidder thence concludes, that the cause of the non-digestion of fat in the cases where Dr. Bernard tied the duct, must have been the occurrence of inflammation of the bowels, partially or generally, and he cannot therefore attribute to the pancreatic juice any of the powers of assisting the absorption of fat, which Dr. Bernard has suggested.

An effect has also been attributed to the pancreatic juice which again seems of very doubtful character. The lime in it has been said to be of value in precipitating and rendering insoluble parts of the bile. But so large is the quantity of the latter secretion in comparison with the small amount of calcareous matter in the former, that this influence, even allowing it to exist, cannot be of any calculable importance.

CHAPTER VII.

SECTION I.—*The Liver as an Organ of Absorption and Bloodmaking.*

FROM whatever point of view we look at the physiology of bloodmaking, the liver always forms a portion of the prospect. If we are considering the preparation of substances for absorption or solution, its secretion plays an important part; if the further fitting of those substances for forming constituents of the nutrient treasure, we find it lying between the place of their first reception and the mass of the blood; if our attention is directed to the retention of the healthy condition, we find it removing noxious or foreign substances both from the incoming nutriment and from that already in circulation. It melts the metal, stamps the coin, and keeps it bright. Whilst as respects the circulation of water with its burdens in and out of the body, it furnishes a large supply to be afterwards taken up.

The quantity of fluid yielded by the liver has been already alluded to, and will again afford matter for consideration when we come to view the bile as a medium of solution. The point of view whence it has now to be looked at, is as a station on the road of absorption.

The blood experiences in its passage through the liver greater known changes than in any other organ, and as recent investigations have been much directed towards them, they may afford a profitable subject for review.

1. The blood of the vena portæ arrives at the liver in a very watery condition, and leaves it much more concentrated. During digestion the water in the portal blood compared with that departing by the hepatic vein is as four to three; after the completion of digestion as twelve to five (*Lehmann*). This is a change that was easy to have been anticipated from our knowledge of the great amount of water required for the bile.

2. A more concentrated condition implies a greater proportion of solid matter in the shape of blood globules; but in addition, it is to be observed that both red and colourless globules are equally increased, and that the former in the hepatic veins are stouter, and less easily destroyed by water than in ordinary blood (*Lehmann*).

3. The blood of the vena portæ is rich in fat, while that of the hepatic vein has lost this peculiarity. It has come in from the food, and is converted in the liver into part of the bile. Compared with the blood of the general system, the portal blood contains double the amount of fat in the jugular vein (*Lehmann*).

4. In proportion to the blood globules, the albumen is increased in its passage through the liver.

5. The salts are diminished.*

6. But the most suggestive of future discovery of all observations on the liver, is that made by Dr. Claude Bernard—namely, that which seems to establish its power of making sugar out of the constituents which the portal blood brings to it.

Dr. Bernard proves his point in the following way:—

1. In man, and in a variety of animals, mammalia, birds, reptiles, fishes, mollusca, experiment proves that the blood of the hepatic veins contains a notable quantity of sugar.

2. The sugar is independent of the quality of the food, and is not derived from that source. For it is found in animals fed exclusively on meat, and in which the blood of the portal system was entirely free from it.

3. A curious circumstance connected with this *hepatic sugar* is the influence of the nervous system over it. Whatever the nature of the food may be, sugar may be made to disappear wholly from the liver by the division of the pneumogastric trunks, or in any way by abolishing their healthy action. Strange to say, an opposite effect—that is to say, an excessive appearance of sugar, an artificial diabetes—was accidentally found to be the result of puncturing a certain spot, accurately defined by the author, in the medulla oblongata, between the trunks of the pneumogastric and acoustic nerves.†

The little we know about these various functions of the liver, the strong probability that many more are unknown, obscurely indicated by apparent chemical variations in the iron and other constituents of the blood, are sufficient to add a mysterious interest to the organ, and to show that some dawn is breaking on its history. It is placed now beyond all doubt, that the ancient surmises about the sanguifying properties of the liver, almost forgotten by all but antiquaries, are not all dreams, but farsighted guesses at truth.

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* Lehmann's *Phys. Chemie*, "Blut," vol. ii., p. 249.

† *Comptes Rendus de l'Académie*, vol. xxxi., p. 571. 1850.

The structure of the liver is easiest understood by putting out of view for the nonce the hepatic artery, the nourisher of its substance, and looking upon it as a mass of ultimate separate cells, among which mass the portal veins, the hepatic veins, and the hepatic duct ramify, which three systems of tubes are the representatives or carriers respectively of blood going *into* the liver, blood going *out* of the liver, and bile originating *in* the liver. These cells are massed together into the little lumps, about the size of pins' heads, so familiar to us as the "*lobules*" of the liver. Between the lobules, and separating them from one another, lies a network of portal veins. The middle of each lobule is occupied by a network of capillaries, which empty themselves by one vein into the hepatic venous system, and this unites with its neighbours to form the larger hepatic veins. The portal system is therefore like a spongework, with round (or rather polygonal) interspaces holding small masses of cells: the hepatic venous system is like a head of cauliflower, with the cells clustered around its extreme buds. Amongst the lobules commence the minutest twigs of the bile-duct, which twigs some anatomists think form a lattice-work, but the best and most recent observers view as rootlets with blind extremities. The bile-duct system may be compared to a tree root implanted in a lumpy soil, which does not enter the lumps, but wanders about amongst them. It ramifies among the portal veins, but does not interfere with the extreme plexus in the lobules. This is a rough sketch indeed of the ultimate anatomy of the liver, but it may serve as a form of arrangement for the multitude of details which crowd all minute descriptions of the organ.

The difficulty and doubt which attend on a demonstration of the minute anatomy of the liver, arises from the necessity, in microscopic examinations, of viewing parts in their sections, which of course almost always destroy all traces of continuous tubing. It is like trying to draw the waving foliage of a birch tree with no guide but the stump of a broom. The above delineation has been derived from a paper by Dr. Handfield Jones, Assistant-Physician to St. Mary's Hospital, published in the *Philosophical Transactions* for 1853. Dr. Jones thus words the description of his latest observations:—

"In many, if not in all London dogs, and in some rabbits, there is found a peculiar condition of the excretory apparatus of the liver, which renders it comparatively easy to trace and follow the ducts to their terminations. If thin sections be made of such livers, the ducts are seen as opaque tubes or tracts, appearing whitish by direct light, which come up from below at the 'spaces' where three lobules adjoin, divide irregularly, and run for a varying distance along the fissures. These tubes run often a long distance without branching; they are most often single, one only traversing each portal canal or fissure, and what is especially remarkable, not maintaining any close relation to the wall of parenchyma, between which and them a distinct interval is often to be seen. Their mode of termination varies; sometimes they break up into a few delicate branches, which may give the appearance of a plexus; sometimes they terminate by apparently losing themselves, that is to say, they gradually cease, their structure becoming indiscernible beyond a certain point, or breaking up into a mere streak of oily molecules. Generally I think the ducts, as seen in these specimens, are confined to the canals and fissures, but minute branches are often seen which just enter their substance for a little way. I have never observed anything that in the least indicated that the ducts formed a plexus containing the cells in anastomosing tubes as described by Dr. Leidy. The opacity which renders the excretory ducts thus unusually distinct is occasioned by a deposit of minute oil-molecules between the nuclei which intercept the light, this oily matter replacing in part the ordinary granular basis-substance, and representing the oily matter which occurs so abundantly in the cortical renal tubuli of all London cats. It is perfectly clear that in neither of these cases it interferes in the least with the healthy discharge of the function, and we may learn that excess alone of oil in any part does not constitute 'fatty degeneration.' The epithelial particles of the gall-bladder in these cases are loaded with oily molecules; they easily break up, and give exit to it very soon after death. No such oily accumulation occurs, at least necessarily, in the parenchymal cells: a further confirmation of the opinion above stated, that these cells are not, *quoad* position, a continuation of the epithelium of the ducts.

"In some human livers I have recently observed the ultimate ducts in a very satisfactory manner, and believe on the whole that the mode I am about to mention is the best for obtaining a view of their course and relations. A very thin section of the liver must be made at one or two lines' depth from the surface; this is to be treated with acetic acid, and moderately compressed; if the liver be tolerably free from oily matter it will now become much more transparent, and on careful examination of the portal canals, spaces, and fissures, some ducts will be found, and their course may be traced. It is manifest that in this way of proceeding the ducts are examined *in situ*; and if the observer has previously acquainted himself with their appearance by dissecting them out as they lie in the Glissonian sheaths, he will have no difficulty in recognising them and following them, though he may have much difficulty in convincing himself of their actual mode of termination. Their termination by distinctly closed extremities I have certainly observed, as well as the slight amount of ramification they present, and the little intimate relation they appear to hold to the walls of parenchyma between which they run. In many fissures not a trace of them can be seen; and in those where they exist it is manifestly impossible that they can come into relation with any more than a small portion of the parenchyma. How then, if all the cells secrete bile, could this make its way into the ducts?"*

The following observation, however, by Drs. Bidder and Schmidt, at the Derpt laboratory, seems to show that in *some* vertebrate animals at least there are free communications or anastomoses between the gall ducts. In birds the cystic duct and the hepatic duct do not, as in mammalia, join, but open into the intestine by distinct passages; so that if one be tied, bile will still go on escaping by the other. Now in one set of experiments on geese, the above-mentioned physiologists opened a fistula into the cystic duct, and *tied* the hepatic duct; in another set they opened a fistula into the cystic duct, and leaving the hepatic duct *permeable*, they measured the bile which flowed from it into the gut by securing the latter. Had then these two ducts been like separate trees, spreading their rootlets into the substance of the liver without communication, the quantity collected from them jointly ought to have been much greater in the second set of experiments than in the first:—the full action of both would have produced a greater amount of secretion than where one was, practically speaking, annihilated. But such was not the result: the quantity collected was entirely unaffected; indeed in one of the former set surpassed several in the second set of experiments. Hence we are driven to conclude that in geese at least there are anastomoses of the duct system.†

The cells, the masses of which constitute the lobules, are in form under the microscope exceedingly like the smaller sort of epithelial scales which line the mouth; being generally polygonal, though often more or less irregularly rounded. They are also about the size of the smaller sort of scales above named. It was apparently this similarity of appearance which led anatomists to try and make them out to be like the epithelium of the mouth, a lining membrane—in fact, an epithelium of the bile duct. But such does not seem to be the case; they are described by Dr. Jones and Professor Kölliker as a *paren-*

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* Dr. Handfield Jones in *Philosoph. Transact.*, 1853.

† Bidder and Schmidt, *Die Verdauungssäfte*, p. 204.

chyma, not an *epithelium*—a *mass* into which tubes enter, not a *lining membrane* of tubes. This is a matter of no little weight as regards the light in which we are now looking at the liver; for if the chief part of the organ, as these cells no doubt are, were made up of the lining membrane of the bile ducts, then the secretion would naturally appear the primary object of the whole viscus. But if, as Dr. Jones's investigations seem to show, their main physiological character is that of an independent mass interposed between the portal and hepatic plexuses, *in opposition to which only* the bile ducts lie, the changes it effects in the blood will be the prominent duty of the main bulk of the liver.

We have before seen that one of the most striking of these changes was the formation of sugar. The analyses of Mr. Blyth, detailed in Dr. Jones's paper, point out the cells as the seat of this change; for though no bile was found in them, abundance of sugar was detected whenever the organ had been in a state of healthy activity at the period of death. It was found too, by some other experiments made by Mr. Noad, that the amount of sugar was dependent on the food, for in animals deprived of it the sugar vanished. Now, as the sugar does not go into the bile, and does go into the blood, leaving by the hepatic vein, we have a fresh corroboration of the justice of the position assigned to the liver, as a stage in absorptive blood-making. The main mass of it is employed in changing the blood, and does *not* (as far as we know) assist in making the chief constituents of the bile.

It is stated above that no bile was found in the cells. Now in examining them with the microscope, besides a nucleus and nucleolus, there is seen inside a quantity of finely-granular substance, which a yellowish hue would at first induce us to pronounce bile, and perhaps the application of Pettenkofer's test to a thin slice of liver may aid that impression; but as it appears that albumen, as well as cholic acid, produces a crimson colour with sulphuric acid and sugar, the argument would be fallacious; in fact a thin slice of kidney was found by Dr. Jones to exhibit this crimson colour quite as well as liver. Further experiments on watery extract of portions of liver, from which the albumen was separated, and on alcoholic extracts conducted

Mr. Blyth in the laboratory at St. Mary's Hospital, showed absence of cholic acid from the hepatic cells. Bile without lic acid would be an army without soldiers.

Yet the yellow hue is no fallacy, arising from the refraction ight; the extracts made were often stained of a deep saffron, hence Dr. Jones calls the substance "bile pigment,"—a bad m, for it seems to imply that the only use of it is to act as a nt, and bestow a pretty colour for the special delectation of tomists, of which we have no proof. Other experiments rded strong suspicion of the presence of glycocol also.

In fine we may conclude:—

1. That a yellow coloured matter, and perhaps glycocol, are med in the cells; but that the chief constituent of the bile, lic acid, must be formed by the ducts.
2. That a copious amount of sugar is formed in the cells, and forwarded into the hepatic vein, but not into the bile ducts.
3. That the sugar is formed in consequence of taking food.

From the above conclusions is manifest the propriety of class- the liver as *an organ of assimilation lying on the direct road absorption.*

SECTION II.—*The Bile.*

Several circumstances have contributed to make the bile cupy a position in our views of digestion, perhaps rather gher than it is entitled to. This is to be accounted for, partly the large size and exposed position of the liver, joined to notion that the principal business of all this mass was to crete bile, and that the business of this bile when secreted was take a share in digestion, proportioned to the bigness of the gan forming it.[*] The reasons already given in the last sec-n for assigning more important functions to the liver than manufacture of bile, will diminish some of this prestige, and recent researches into its true value tend to prevent too gh a part being given it on the one hand as a solvent, or on other as an excretor of noxious material.

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[*] A vulgar etymological error has given it a great importance in digestion. ple constantly talk about "having the *bile*," supposing that their disorder is nected with the secretion of the liver: the proper expression is "the *boil*," as pronounced in the north of England, intended to describe the restlessness fermentation going on inside during these attacks, but perverted by our thern pronunciation.

The questions which most naturally arise respecting the bile are—its quantity—its rate of flow at different times—its variations according to the quantity and nature of the food or other ingesta—its physical properties and their variations—its action on alimentary matters or other contents of the digestive canal—its true position in the organism, whether as an excretion, nutriment, alterative, or vague "stimulant"—all these have a most practical bearing on daily life, and have all received much recent light from observations not familiar to the English public. To answer them, fistulous openings have been made into the gall-bladder or ducts of various animals, and while all passage into the intestine was cut off by a ligature, the secretion was collected at leisure. *At leisure* may be fairly said, for M. Blondlot kept a dog in this condition alive for five years, and some of those used in the Derpt laboratory were mercifully killed after two months' observation, still in a viable state. The operation is a less violent one than might have been anticipated; of eleven dogs so treated, with the precautions detailed by Dr. Bidder, only two died of peritonitis. The injury also was less than might be supposed, the principal inconvenience arising from fœtor of breath and flatulence—symptoms in spite of which many of our own species continue their daily occupations and amusements. The authors too seem most careful that the animals should be in as normal a condition as possible; for example, on cats they did not begin to record their observations till the pulse and breathing were of the ordinary rapidity, and the creature would purr when stroked; and on the first shivering ceasing to take notes. And the dogs are described as cheerfully disposed, rising up and following their masters round the laboratory when called.*

A.—*Quantity of the Bile.*

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* M. Blondlot's pointer was still more frisky; she used to go shooting with her master, and suckled annually a litter of puppies for the five years he kept her. If the hepatic duct really was impervious, her food must have been no slight expense, if we may judge from the observations made at page 173. See *Compte's Rendus de l'Académie des Sciences*, June 23rd, 1851.

Yet the yellow hue is no fallacy, arising from the refraction of light; the extracts made were often stained of a deep saffron, and hence Dr. Jones calls the substance "bile pigment,"—a bad term, for it seems to imply that the only use of it is to act as a paint, and bestow a pretty colour for the special delectation of anatomists, of which we have no proof. Other experiments afforded strong suspicion of the presence of glycocol also.

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Cats	Dogs	Sheep	Rabbits	Geese	Royston Crows—	
secrete in twenty-four hours for each kilogramme by weight						
Grammes	Grammes	Grammes	Grammes	Grammes	Grammes	
14·500	19·990	25·416	136·84	11·784	72·096	of fresh bile.
0·816	0·988	1·344	2·47	0·816	5·256	of solid material therein.
$\frac{1}{70}$	$\frac{1}{50}$	$\frac{1}{40}$	$\frac{1}{7}$	$\frac{1}{80}$	$\frac{1}{13}$	Proportion of fluid bile to the animal's weight.

The medium position occupied by dogs, in the proportionate amount of bile secreted for the weight of the body, and the similarity of their food to that of the human species, renders the application of observations made upon them to man not altogether unsuitable. On this estimate we secrete daily between 3 and 4 pounds of bile.

It may aid in giving us confidence in the above detailed results, to call to notice the fact that *weakness and disease* decrease the quantity of bile, as of all other secretions. If we look over the daily record kept of the four dogs retained under observation for about a month with hepatic fistulæ, we shall observe this fact clearly exhibited. In a dog that died, during the last week there was only one day on which any bile flowed from the fistulous opening. (Second dog.) In two that kept up their flesh and weight, the amount varied with the diet and other circumstances, but never diminished as in the former. (Third and fourth dogs.) This fact ought perhaps to be taken into consideration when we give our judgment on the correctness of the estimate formed of the quantity of bile secreted, from observations on animals placed in the unnatural conditions of those experimented upon. We may feel satisfied that such estimate is below rather than above the mark, and that in ordinary health the amount which flows must be very much greater than is here calculated upon.

It might have been supposed that some aid in the estimation of the amount of bile secreted by different species and different individuals might have been derived from a comparison of the weights of their livers; one would have guessed that the largest organs would be the most productive; but such is not the case.

A series of careful observations are detailed by Drs. Bidder and Schmidt, and from them there appears to be no relation between the amount of secretion and the size of the liver. Indeed so much the contrary, that in the sheep experimented upon the smallest livers gave the greatest proportion of bile, while in the cats quite irregular ratios were kept.

B. *The Rate of Hepatic Secretion at different Times.*

The secretion of bile appears to be continuous, but is augmented and diminished from time to time according to the stage of digestion. It reaches its maximum in cats, at from ten to twelve hours after the last full meal; in dogs, at from thirteen and a-half to fifteen and a-half hours. From that period to twenty-four hours it gradually decreases, till it comes down to the quantity secreted one or two hours after feeding. Longer abstinence diminishes the amount more and more.

For instance, if a cat weighing 1 kilogramme in the second hour after a meal of meat secretes 0·492 grammes of fresh bile, the amount begins to increase extraordinarily, so that in the fourth hour it secretes 0·629, and in the seventh as much as 0·750, in the eighth 0·825, in the tenth 0·850 grammes; so that in each hour between the second and the tenth there is a proportionate increase in the horary secretion of 0·045 of a gramme. In a similar way too the decrease, which commences after the tenth hour, takes place pretty quickly, so that from the tenth to the twenty-fourth it is at the rate of 0·028 gramme per hour.*

These observations are of the greatest importance, for we may reasonably assume that the period at which the greatest quantity of bile is supplied is that at which it is most required for the uses of the animal economy. If its immediate action on the food lately received into the digestive canal were required, would it not be furnished in greatest amount at the time of most active digestion? If on the other hand it is most wanted when the process is nearly or quite complete, is not the observed gradation of the flow that which was to have been anticipated?

I think too, that we may from hence learn something useful to us, in our employment of medicines which increase the action of the liver. The better we know the habits of Nature, the more beneficially can we follow her or modify her, according to our requirements. But these considerations belong more properly to a future page.

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* Lehmann's *Physiol. Chemie*, vol. ii. p. 78.

C. *The Variations of the Hepatic Secretion according to the Quantity and Nature of the Food.*

A *full* diet increases not only the quantity of the bile, but also the amount of solid material therein. Thus it was found by Drs. Bidder and Schmidt that whilst a cat on ordinary diet secreted 0·807 of a gramme per kilogramme of weight hourly, and of solid material 0·045 of a gramme, on very full flesh diet the secretion was in one cat 1·185 gramme of fluid, and 0·062 of a gramme of solid, in another cat 1·003 of fluid containing 0·068 of solid. The same fact was fully confirmed by observations also upon dogs and geese, the details of which are analogous to the above. Perhaps this variation according to the amount of diet may be connected, as cause or effect, with the facts already noticed concerning the influence of disease on the bile.

Fatty food instead of increasing, as might have been expected on theoretical grounds, the quantity of bile, extraordinarily diminishes it. Thus in a mean of three experiments on cats, the hourly discharge after a diet of pure fat was of bile 0·327, of solid matter in it 0·036 of a gramme. We might have supposed that the formation of a substance which is the most hydro-carbonaceous in the body would have been augmented by a peculiarly hydro-carbonaceous aliment, but such is decidedly not the case. Nay, so far from it, that the numbers given above correspond most closely to what would probably have been the quantity of bile secreted by the animals in a state of complete deprivation of food. Pure fat diet is as bad as starving diet.

Flesh diet causes the secretion of more bile than vegetables. For example, in an experiment made by Dr. Nasse on a dog,* a diet of bread and potatoes caused a daily secretion of 171·8 grammes, in which was 6·252 of solid matter; whilst meat made it amount to 208·5 of fluid, or 7·06 of solid residue.

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* Nasse, *Commentatio de Bilis quotidie à cane secretâ copiâ*, &c. Marburg, 1851.

Water increases the quantity of the bile within an hour after it is drank, and increases not only the quantity of fluid, but also of the solid contents, though in a less proportion. Thus a dog weighing about 5 kilogrammes, which after a meal of 185 grammes of *beef alone* secreted in an hour 2·283 grammes of bile with 0·135 of solid matter in it; after a meal of 25 grammes of *beef and* 158 *of water* secreted 4·030 of fluid, and 0·117 of solid bile. And the same dog after 185 grammes of *water alone*, secreted no less than 5·165 of bile, or 0·143 of solid matter. And the same thing was observed in the three other similar experiments.

To this Dr. Nasse adds, that though water increases the fluid bile and also the organic solid constituents, it does not augment the amount of salts.

Mercurial medicines (viz., the grey oxide and calomel) were found, in some experiments made by Dr. Handfield Jones on animals, to increase the production of yellow matter in the cells of the liver.

Muriate of manganese and *colchicum* had also a similar effect, which was strong in the order in which these substances are placed.

Taraxacum appeared to have no effect.

Nitro-muriatic acid was found, on examination after death of a cat who had taken it, not to have increased the yellow matter in the cells, but during life it has caused a greater flow of bile *per anum.*

Aloes, *oil of turpentine*, *rhubarb*, increased the flow of bile into the intestines, but after death no yellow matter was found in the cells.

Mercury has also caused a very great sanguineous congestion of the liver, which on the contrary was pale in the case of the latter classes of drugs which had not augmented the yellow matter.

Antimony produced in the liver, as in all the mucous membranes, a copious flow of water and mucus.*

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* Dr. H. Jones in *Medico Chirurgical Transactions*, vol. xxxv., p. 249, and *Medical Times and Gazette* for March 19th, 1852.

We have thus put under our command most powerful agents for modifying the quantity and quality of the bile. We may do so in a great variety of ways, combined or simple, and each way may have a different effect on the human body, both in regard of the solvent, excretory, or converting power of the secretion. It cannot be doubted that further inquiry will extend very much our knowledge of the action of the above mentioned and many other remedies and modes of discipline, so as to confer incalculable benefit on national medicine.

D.—*The Physical Properties of the Bile and their Variations.*

Pure bile as it flows from an hepatic fistula, is a transparent fluid, without any organic forms or insoluble matters in it, except as the result of a mucous or catarrhal state of the gall-bladder, or the accidental admixture of blood.

The colour of the bile presents a great number of variations, which however are capable of being brought under certain laws. It depends, for example, very much on its greater or less duration and consequent concentration in the gall-bladder. Thus in cats, dogs, and sheep, the fresh bile contains five per cent. of solid matters, while that which is taken from the gall-bladder contains often from ten to twenty per cent. That of rabbits, when recent, but two per cent.; of geese and crows seven per cent.; yet in both there may also be found from ten to twenty per cent. in the gall-bladder. In sheep, however, probably in consequence of its shorter habitual duration, the solid part was not raised more than from five per cent. to eight per cent. In the Royston crows on the other hand, it rose from seven to twenty-five per cent.

Again, the colour varies with the nature of the creature's food. In carnivora it is yellow, from golden to burnt sienna; in herbivora green, from grass green (as in rabbits) to sea green (as in geese), or olive green (as in sheep.)

These varieties of colour are partly dependent on the amount of oxygen admixed, for by artificial addition of that element the yellow bile may be made green, and the green bile when deoxidated by zinc turns yellow. We may conjecture then, that it varies according to the quantity of oxygen brought to the liver by the blood.

Fresh flowing bile which had not been detained on its course was found by Drs. Bidder and Schmidt always neutral. *Alkaline* reaction was caused only by the admixture of the thickened contents of the gall-bladder, which contained mucus. If, however, this mucus was removed by precipitation, the neutral condition was restored. So that an alkaline fresh bile can only be so by being mixed with mucus. *Acid* bile can only arise from its decomposition.

E.—*The Action of the Bile on Aliments, &c.*

It is usually taken for granted that the bile is capable of dissolving, and so assisting in the absorption of some part of the food. But there has till lately been no very distinct proof of its possessing this power. The Derpt Professors, so often quoted, confirm Dr. Hünefeld's* statement that "picromel," that is bile freed from mucus, is capable of dissolving blood globules; but that bile in its natural unchanged state possesses this property they deny; and it seems according to their experiments not able to convert coagulated albumen even after many days' maceration. They say that Dr. Hünefeld's experiments are correct enough, but have been in error quoted as if applicable to pure bile, whereas they relate to a mixture of it with mucus.

The following experiment of theirs shows how little solvent effect it has upon that important form of albumen—casein. Three portions of cheese were set to digest for twenty hours at 100° Fahr., one in pure water, another in water and bile, and a third in water and glycocholate of soda. On weighing them it was found that the first and the third had lost seventeen per cent., but the second only eleven per cent. of its weight. Instead therefore of being a solvent, it is less so than pure water.

Further than that, it does not even assist other juices in digesting albuminoid substances. Drs. Bidder and Schmidt examined with the microscope the fæces of dogs fed on flesh alone, in whom all entrance of bile into the intestines was cut off, and yet found no remains of muscular fibre; it had all been dissolved without the aid of bile, except in cases where diarrhœa existed.

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* Hünefeld, *Chemie und Medicin*, p. 105.

To test the influence of bile over the digestion of starch, a dog, where no bile was allowed to flow into the intestines, was fed for eight days on rye bread. The quantity of fæces was greatly increased, they had no fœtid odour, and were decidedly acid. Still no starch granules were to be found by microscopic examination, and no more starch by the iodine test than is usual in healthy dogs fed solely on bread. Another dog fed solely on wheaten bread exhibited no trace of starch in the excrements at all. It was observable, too, that the dogs did not lose weight during these experiments, so that the arrest of the secretion of the liver presented no impediment to the absorption of nourishment from amylaceous food.

Its action on starchy and albuminous aliments is therefore equally null. Indeed, since starch has saliva and pancreatic juice to digest it, and albumen gastric juice, why should the bile interfere?

Fat now remains. We have already seen (page 102) how the villi take up fat with ease. The question is, whether any modification of it by any of the digestive fluids is required previous to that absorption, and whether the bile is the one to make the modification?

To try this, a dog with hepatic fistula was fed with food containing a weighed quantity of fat, but allowed to swallow a small quantity of bile by licking the opening. By examination of the fæces it was found to take up daily by absorption for each kilogramme of its weight 2·24 grammes of fat. Another dog was treated in the same way, but all admixture of bile was entirely prevented. It was found to take up but 1·56 gramme of fat. A healthy uninjured dog was found to absorb as much as 11·1 grammes of fatty substances to the kilogramme in the twenty-four hours. Hence it is clear that though some fat may be absorbed without the aid of bile, yet that a small addition of the secretion makes the quantity considerably greater, and that an unrestricted flow into the intestine increases it five- six- or seven-fold.

A further proof of these facts was derived from the chemical analysis of the chyle found in the thoracic ducts of these dogs after their death. In a strong healthy dog the fluid was milk-white, and contained 37·05 parts in 1000 of fat and other organic matters united to it. The chyle of two dogs with biliary fistulæ was transparent, opalescent, coagulating very rapidly from its great amount of fibrine, and containing but 8·34 parts in one case and 3·03 in the other of fat and the organic matters united to it. Now as the other constituents of the chyle differed but little in the healthy and the mutilated dogs, the variation can be attributed only to the artificially induced deviation from normal life, and we cannot but conclude that it is to the bile we are to look for the chief aid to the absorptive solution of fat to the animal economy.

So convinced are the above experimenters of the correctness of this view, that in the case of M. Blondlot's dog with a biliary fistula, in whose fæces no fat was to be discovered under oleaginous diet, they think it impossible but that the ductus choledochus must have become re-established.

The experiments are indeed most valuable, and prove a great deal more than those in which the bile ducts were tied, and then the contents of the lacteals observed. In the latter there existed always a fallacy in the accident whether or no a certain quantity of bile chanced to remain in the intestines after the ligature. If it did, then of course fat was dissolved by it in the natural way, and the lacteals, as in M. Magendie's cases, contained white fatty chyle. If it did not, very little was taken up, and the chyle was transparent, as in Sir B. Brodie's familiarly known experiments.* It will be noticed that the plan adopted in those detailed above entirely removes this source of error, so that I think we may really view the matter as quite decided by them.

The importance to the animal economy of bile and the fat which it aids in absorbing, is strikingly shown by the wastefully large appetites exhibited by the dogs with biliary fistulæ. They ate enormously, and by no means gained weight in proportion. The explanation of this is that the carbon usually taken up as fat was unabsorbable from the want of bile. Yet the same amount of carbon was still required by the respiratory process. This then had to be supplied out of the albumen which usually goes to nourish the body of carnivorous beasts, and the muscles and other solid parts were obliged to be starved in consequence of the irresistible call of the lungs for carbon. Medical men will not fail to remember how often the same phenomena occur in patients with occlusion of the biliary ducts, how ravenously sometimes they will eat in spite of the sensations of illness which depress them.

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* *Quarterly Journal of Science*, Jan., 1823.

The question however remains, *in what manner* the bile gives assistance to absorption.

Stale bile is well known to unite itself with oil into a soap, and the use of it for the removal of grease spots from woollen textures and in cleaning carpets is familiar to all dyers and scourers. And fresh bile, too, if shaken up with *oleic acid*, will dissolve some of it, though by no means so much as it would have to do if it had to act thus upon the whole of the fatty substances absorbed daily. To do that more bile than is secreted would be required.

And still the difficulty remains that it will not unite itself with *neutral* fat, and as the majority of the oleaginous matter taken as food is in that condition, there is no explanation given how the aid to absorption which has been found to exist is brought about. The difficulty may be thus stated—neutral fat is found in the food, neutral fat is found in the chyle—how does it get from one situation to the other through a membrane saturated with water, utterly incapable of uniting with the said fat?

I fear it must be said that at present this question cannot be answered. That fat does thus pass is clear enough from the above experiments, and from others already detailed, where it has been *seen* on its transit (page 102). But under what form or by what laws, and how the bile or any other digestive fluids assist it, is as yet unknown.

To show how undecided this question is, several opinions on the subject of distinguished physiologists are here given, premising that they all equally await the proof of decisive experiments.

Dr. Bernard thinks that previous to absorption a decomposition of oil takes place, and that it is resolved into glycerine and an acid, butyric, oleic, margaric, as the case may be. His reason for thinking this is, that when pancreatic juice (to which he attributes the chief agency in this business) is mixed with butter, an odour of butyric acid is given off.* It can hardly be allowed that this is a sufficient argument, for the quantity thus changed is so small that it would not be nearly enough to supply the requirements of the economy. Besides which he does not at all explain how it is that the acidified fat becomes again resolved in the chyle into a neutral condition.

Dr. Moleschott however, thinks that such is the case, and that the fat is thus acidified in the digestive canal, saponified by the digestive juices, passed in a state of soap through the absorbing membrane, and then again rendered neutral in the lacteals.† The principal objections to this are, first, that fatty acids are not found in the bowels in a healthy animal, and secondly, that unsaponified fat can be seen in the epithelium of the villi (see page 102.)

Dr. Frerichs thinks that oil is made into an emulsion by the motion of the bowels and the thick abdominal fluids, and being thus in a state of fine division is able to force its way bodily into the ends of the villi.‡

Dr. R. Wagner thinks that particular portions of the mucous membrane are appropriated to the imbibition of fat, and kept free from that saturation with water, which would be an impediment to it. He supposes the bowels, in fact, to be piebald over with different kinds of absorbing membrane suited for different substances.

Dr. E. H. Weber holds a somewhat similar opinion, only he assigns the piebald condition to individual cells instead of to different spots.§

The opinions held by Drs. Bidder and Schmidt themselves have been already detailed, with the reasons for them (page 127 *et seq.*)

An action of the bile on fleshy matters, which is of no slight importance to our health and comfort, is shown by experiments on dogs. It was found that when no bile flowed into the intestine, rapid decomposition occurred in these sorts of food: continuous rumbling of the abdomen, the secretion of fœtid gases, and of fæces smelling like carrion, immediately followed, though in truth no further deleterious consequences of this inconvenience were perceived even after eight weeks. In fact a condition of flatulent dyspepsia was artificially induced, not a poisonous or fatal disease truly, but an excessively distressing one to our species. When the animals were fed on bread only, these symptoms ceased, the fæces and abdominal gases were odourless, and were sour rather than putrid.

From thence we may conclude that the bile acts on albuminous matters as an antiseptic, preventing their putrid decomposition, and preserving them safely to be exposed as much as possible to the absorbents of the alimentary canal; and that at the same time the excessive acid fermentation of vegetable starch is checked, so that it may proceed gradually and as required by the digestive process. Now as both putridity and fermentation are most likely to occur in excess at a late period only of digestion, we have (partly at least) explained the reason why the bile should be supplied in greater quantity twelve or fourteen hours after a meal than at any other time. It is furnished *then* to correct an evil *then* most likely to occur.

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* *Archives Générales de Médecine*, Jan. 1849, p. 78.

† Moleschott, *Physiologie des Stoffwechsels*, p. 209.

‡ Article 'Digestion,' in Wagner's *Dictionary of Physiology*.

§ Bidder and Schmidt, *Verdauungssäfte*, p. 230.

F.—*The True Position of the Bile in the Organism.*

Is the bile in fact merely an *excretive*, effete, used-up matter, which it is for the good of the body to get rid of by the easiest route as being useless and detrimental? Or has it farther uses in the organism after it is separated from the blood, uses which it would be a serious injury to the economy to be without? The answers to these questions are much facilitated by the experiments detailed in the previous sections. Were it merely an excretion, we might have *à priori* conjectured that the outlet for it would have been placed nearer the external surface of the body, so that a useless matter might have as little way to go as possible before it were entirely got rid of—delay in this case would be an unnecessary risk. Again, were it merely an excretion, the making of biliary fistulæ would be simply the supply of a defect in Nature—the animals so operated upon would not have suffered any inconvenience, and have lived as long and happily as others. But such was not the case. One of Dr. Bidder's dogs on whom the operation was practised lost two-fifths of its weight by the time of death, thirty-four days after the opening was made. Though cheerful and good-natured, and with a good appetite, it lost its hair, and died in fact of debility. A second dog, whose appetite was not so good, died in the same way in twenty-seven days, having lost no less than half its weight. Two other dogs, whose appetites were more voracious, kept up their weight for a couple of months, when they were killed. But all suffered from the flatulent dyspepsia and putrefaction of the contents of the bowels above described. It is clear therefore that it is *not* a mere excretion—that it has uses connected with the nutrition of the body, and that when its admixture with the contents of the alimentary canal is prevented, that loss can only be compensated for by an extraordinary supply of food.

That it is *partly* an excretion may be easily conceded, for in a certain sense not only all secretions, solid and fluid, but also all elements of growth are so. That which forms mucus, gastric juice, hairs, nails, bones, &c., is in the arteries a superfluity, and there is every reason to believe that none of their elements can be stopped in their way out of the blood without injuring the latter. But since it has been shown that many of the evils usually attributed to the retention of bile in the blood equally arise where it has been duly separated therefrom by an artificial opening, and only impeded in its future use as a solvent and antiseptic, our idea of its excretive function is necessarily reduced to smaller compass than before.

What, now, is the amount of bile which really is excreted and thrown away?—what numerical proportion do the useless effete matters in it bear to those which are again resorbed? Drs. Bidder and Schmidt answer that they are at most not more than one-eighth, and very probably under one-fifteenth even, of the solid matter; thus agreeing with Boerhaave and the physiologists of the last century, who held that "almost the whole mass of the fluid secreted by the liver, and poured into the cavity of the intestines, is again secerned or drunk up by the absorbing veins from the alimentary and fæcal contents before they arrive at the anus."*

The estimate of one-eighth was arrived at in the following way: A dog was fed entirely first with black rye bread, then with meat, and then again with rye bread. The fæces passed during five days were collected for examination. Now in the first place it was observed that the colour of the fæces varied strictly according to the diet, showing that at least no very predominant amount of bile, with its brilliant and distinctive coloured ingredients, was present. Had it been there in any quantity, the fæces could not have been black with the rye and grey with the meat diet. Again, the full chemical analysis of these fæces shows among other things the per-centage of sulphur contained in them. Now as bile contains a known amount of the same ingredient, we shall certainly be within the mark, if we estimate by it the quantity of bile present. I say we shall be "within the mark," because, though the presence of bile necessarily implies the presence of sulphur, the reverse does not hold good, for the sulphur may have come from elsewhere. We will say therefore that more bile is contained in the fæces than would be represented by the sulphur found. Analysis showed that the whole of the sulphur in these excreta amounted to 0·384 of a gramme, whereas the quantity of that element in the bile passed from the liver during the same period of five days must have been 2·37 grammes. Thus even of the solid parts of the bile not one-eighth was rejected by the rectum.

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* Van Swieten's *Commentary on Boerhaave*, vol. ix., sec. 918,

But then in these fæces there was contained a large quantity of hairs, swallowed with the food and with the saliva during the canine operation of licking. These hairs contributed of course to increase the sulphur, and when they were removed, and the remaining substance examined, there were only 0·154 of a gramme of that element in it, answering to a quantity of bile amounting to about one-fifteenth of the fæces.

So that we may conclude, not only that the whole of the fluid of the bile, but at least seven-eighths, and perhaps fourteen-fifteenths of the solid matter is again taken up by the absorbing vessels on its road from the liver to the rectum.

To resume—the duties of the bile in the animal economy may be, from the present state of our knowledge, assumed to be:—

1. To remove from the organism, in common with all other secretions, a small quantity of effete matter.
2. In a manner as yet undetermined, to render oleaginous matters more suitable for being absorbed, or else the membranes more suitable for absorbing them, and that at an advanced period in the course of digestion.
3. To prevent the too rapid decomposition of albuminous food.
4. To form an important part of the great system of circulation through membranes, carrying out substances imperfectly fitted for assimilation, and returning them mixed with new matters introduced by the mouth, into the current of endosmotic absorption.

CHAPTER VIII.

THE LARGE INTESTINES AND SUCCEEDING PARTS.

THE comparison of the contents of the large intestine with those of the previous portion of the alimentary canal, shows that in the healthy condition there is very little left for it to do in the way of absorption. Above the ilio-cæcal valve, which is placed as a sort of Rubicon of nutriment between the two guts, there is to be found sugar and bile in considerable quantity, as also some albuminoid matters, coagulable by heat and acetic acid. Beyond the valve, whenever these substances are found in any notable amount, it is to be viewed as a deviation from the perfection of health. What the colon ought to contain is the débris of the food incapable of solution—such as vegetable bones, skins of fruit, hairs, &c.,—together with the decaying, unabsorbable, coloured constituents of the bile, and rather more water than it is quite convenient should remain (*Lehmann*).

The principal business of the colon is the removal of this water, and the formation of the fæces into a solid mass, which may be conveniently retained or expelled at will. At the same time a certain amount of air is kneaded with the mass, which has the effect of making it light and soft without reducing the dryness necessary to the retention of the solid form. This admixture of air in the fæces is not noticed by physiologists, but it may be easily observed: healthy human excrement swims free and high in the water it falls in, but should dyspepsia, diarrhœa, or purgative medicine cause it to be passed in a pultaceous state, it sinks immediately. May it not be partly for this purpose that we always find the colon so full of gases? Is not their want of employment in the healthy way a cause of their being expelled unmixed in flatulent indigestion?

It is very possible, however, that with the water the colon, even in the healthy condition, takes up any matters therein soluble which have accidentally descended to it. We know very well that it *can* do so, by its absorption of medicines requiring no digestive change which are artificially introduced by the rectum; and it appears also capable of taking up albuminous and fibrinous aliments from nutritive enemata, which implies a certain power of independent digestion.

CHAPTER IX.

THE GASES OF THE ALIMENTARY CANAL.

THE following table exhibits a comparison of the gases contained in different parts of the intestinal canal:—

Gas.	In Stomach. Volume per cent.	In Ilia. Volume per cent.	In Colon. Volume per cent.
Carbonic acid	14 (*Chevreul*) 25·2-27·8 (*Chevillot*)	24·39 (*Chevreul*)	43·5 -70 (*Chevreul*) 23·11-93 (*Chevillot*)
Oxygen . .	11 (*Chevreul*) 8·2-13·0 (*Chevillot*)	0 (*Chevreul*) 2-3 (*Chevillot*)	0 (*Chevreul*) 2-3 (*Chevillot*)
Nitrogen . .	71·45 (*Chevreul*) 66·8-59·2 (*Chevillot*)	20·08 (*Chevreul*)	18·40-51·03 (*Chevreul*) 95·2 -90·0 (*Chevillot*)
Hydrogen .	3·55 (*Chevreul*) a trace (*Chevillot*)	55·53 (*Chevreul*)	
Sulphuretted hydrogen .			1·0 (*Marchand*)
Carburetted hydrogen .			5·47-11·6 (*Chevreul*) 28·0 (*Chevillot*)

The excess in which the stomach contains oxygen and nitrogen, very nearly in the proportions in which they exist in atmospheric air, points clearly enough to their origin. They are swallowed in great quantities with the food, and in the shape of frothy saliva. The oxygen is partly taken up by the blood, and partly consumed in decomposing the victuals, so that by the time the gas becomes intestinal, it contains, as is seen in the table, a preponderating quantity of nitrogen, which remains as the *caput mortuum* of the deoxigenated atmosphere.

The increase in carbonic acid and in hydrogen, and the formation of sulphuretted and carburetted hydrogen, are easily conceived to be a result of the fermentation of sugar, and of the amylaceous and albuminous food taken. Indeed the wonder is not their presence, but their presence in such small quantities as is the case in health.

Besides the air swallowed and arising from the chemical changes in the aliments, there is reason to believe that a good deal is secreted from the mucous membrane. Dr. Frerichs, in his article 'On Digestion' in Wagner's Dictionary, mentions having in a dog tied above and below a coil of intestine emptied of its contents, and after a certain time it became filled with air. Unfortunately it was not analysed, so that we do not know what part, though we know that *some* of the intestinal gases may (under abnormal circumstances at any rate) be secreted from the intestine itself.

A question naturally arises, what becomes of all this air swallowed, secreted, and evolved? There are many individuals who do not pass it *per anum* for months and months; indeed, as long as the perfect type of health is preserved, it may be said never to be excreted. And again, of what use is it?

To neither question can an absolute answer be given, but in default of that perhaps the following conjectures may be allowed to have weight. The oxygen may be accounted for partly as being employed in assisting the decomposition of the victuals, and partly as being taken up by the capillaries of the mucous membrane; some too may be dissolved in the water circulating inwards. The excretion of the carbonic acid may be effected by being taken up by the capillaries also, and then carried to the lungs to be sent into the external air. Thus it is treated as a mere excretion, the end of which is to be got rid of. But it is not so entirely useless, or in truth it would have no claim to be introduced here among the great moving agents in digestion. There are several important elements of food, such for instance as carbonate of lime and phosphate of lime, which are insoluble in water, but are soluble in water saturated with carbonic acid. This saturation is effected by the gas which remains in the bowels as a reservoir—as a reservoir, too, where a certain amount of compression is exerted, and the taking up of the carbonic acid is assisted just as in natural springs or in artificial fixed-air machines. This use is really a most important one.

For the nitrogen I do not know how to find a use in the nutrition or modification of the tissues. Some of it is probably taken up by the blood, and excreted by the lungs, as in the expired air a considerable proportion of this gas is known to be found, forming, according to the latest experiments by M. Barral, one per cent. of the whole,* and some may perhaps be made into ammonia. But to that which remains still in the alimentary canal an employment may be assigned, humble indeed, yet contributing most exceedingly to our comfort and health. The fæces when they arrive at the ilio-cæcal valve are almost fluid, and are so largely mixed with water saturated by salts, that they are of greater specific gravity than ordinary water, and either sink in or become mingled with it. If now our digestive organs are not performing their duty well, or pass the mass on too quickly, it comes into the external air in a very similar state to that above described. It is a heavy, unformed, half-liquid lump, diffusing itself most disagreeably through whatever fluid it is cast into, and becoming a nuisance to the neighbourhood. Besides which it is very difficult for the sphincter to hold in, and causes propriety to be a positive pain. When however in the healthy condition this mass is thoroughly impregnated with air, it is so much dried and solidified that it can be made into a stiff mass, which presses equally on the sides of the gut as on the sphincter, and is easily kept in its position. From the quantity of air it holds it is lighter than water, and floats harmlessly away as soon as expelled.

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* *Comptes Rendus de l'Acad.*, t. xxvii., p. 361.

CHAPTER X.

PHYSIOLOGICAL ACTION OF SUBSTANCES SUBMITTED TO ABSORPTION IN THE ALIMENTARY CANAL.

THE proper use of all substances submitted to the process of absorption in the alimentary canal may be described as "nutritive," in a broad sense—that is to say, to cause the process of nutrition, or the renewal of the tissues which constitutes life, to be carried on in a better way than without them. When instinctively or rationally they are taken by a body in health, with the intention of keeping up that health, they are **FOODS**; when administered to a sickly body, that is one whose physiological actions are inconvenient to the individual, with the intention of restoring health, they are **MEDICINES**. Whether an article is food or medicine depends entirely on the intention, and on nothing else.

Both foods and medicines accomplish their objects in one of two ways, in respect of which they may be classed as COMPLEMENTARY or ACCESSORY.

COMPLEMENTARY foods or medicines are those whose nature enables them to become portions of the typical solids or fluids of an animal body. They can rebuild or renew by their own substance those organic compounds which chemical decay is continuously employed in disorganizing.

Different sorts of complementary foods are required for different parts, and must be proportioned in kind and quantity to the wear of those parts.

ACCESSORIES are those by whose use the moulting and renewing (*i. e.* the metamorphosis) of the organic structures are modified, so as best to accommodate themselves to required circumstances. They may be subdivided into those which *arrest*, and those which *increase metamorphosis*, and each subdivision again according to the various tissues upon which their action is mainly exercised. Thus there are arresters and hasteners of metamorphosis of the bones, arresters and hasteners of metamorphosis of blood globules, &c., though in truth we do not yet know enough to assign them all their places.

Having uses they have also abuses; the complementaries may be taken in excess, and the accessories when not required by the circumstances of the individual; the first are then *indigestible* or *noxious*, and the latter *intoxicating* or *poisonous*, according as they are food or medicine.

As this classification is of some importance in a practical point of view, it is worth while to employ a few pages in discussing the ground on which it stands. The assumption on which it is based is that each animal requires a certain amount of several organic substances to supply the continuous waste or moulting of the tissues—that if it takes more it has too much, if less too little.

The difficulty is to apply this to practice, and to say when an animal has exactly enough to eat.

Dr. Frerichs in his well-known article on 'Digestion,' in Wagner's *Physiological Dictionary*, has endeavoured to give us a way of finding an answer by the chemical analysis of the secretions. He reckons up how much urea, how much carbonic acid, and what salts are separated from the organism *during the entire deprivation of food*. He argues that such is the necessary loss of substance in the body, and such must be the necessary supply. If by lungs, kidneys, skin, &c., so much carbon, nitrogen, hydrogen, &c., is given off, the amount of aliment required to be made into the blood is that which contains an equal weight of those principles, in order that life may be maintained in the same theoretical stationary condition. Such a method of interrogating Nature has been adopted also by Drs. Bidder and Schmidt, as may be seen by the work of theirs so often before quoted. A worthy Dutchman, Dr. Donders,* objects to this indirect mode of computation, and compares Dr. Frerichs to a grocer who, in order to estimate his stock of sugar, burns some of it and weighs the ashes. We must demur to this comparison: the philosopher is not in the condition of a shopkeeper who in taking stock has everything under his thumb, and has only to produce his scales, and to measure right on end; he is rather like an income-tax commissioner, with an uncommonly refractory return before him, an obstinate, sly fellow, who has kept no books, and gives evasive answers—such, with reverence be it said, is Nature. The commissioner acts just like Dr. Frerichs, he says, "you have expended so much in improving your premises, so much in household expenses, &c., so your income must be at least equal to that amount." There does not appear any possibility of applying the direct method to the discovery of the exact quantity of food required to be made into blood, for the very obvious reason, that we cannot ascertain how much of that put into our mouth is wasted; and it is probable that if not by this, at any rate by some similarly indirect method, our future knowledge of the subject will be directed. It must be observed, however, that in Dr. Frerichs' argument it is assumed that in the starving condition the organs will still continue to remove from the body in a minimum quantity those effete particles which are no longer capable of life; and that the metamorphoses of tissue which then take place are all that are absolutely requisite for keeping together mind and matter. Here, if anywhere, lies the fallacy: we have no proof that in deprivation of nutriment the ultimate particles are not abnormally retained in the organism, and that starvation is not in fact a gradual interstitial death, as well as an exhaustion by unreplaced secretion. An architect might say "I will calculate the quantity of stone and timber washed away by weather and wear from a building, and will send in so much to replace it;" but no, that would not do; he must supply new timber and new stone in fresh quantity to push out that which is becoming injurious by decomposition—the removal must be an active leading process, or the building goes to ruin. It is not stated that such is the state of the case in our animal body; but there is no proof that it is not, and if it is, then clearly enough the *excreta* are not a measure of the required *ingerenda*. If however the point can be made, that the removal of substance by secretion up to a degree inconsistent with life is the sole cause of death by starving,—that the necessary interstitial disorganizations go on without food as quick as with it—

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* *Die Nahrungsstoffe*, s. 8 (a German translation from the Dutch.)

this indirect mode of reckoning the amount of elements which must daily become blood will be of great theoretical importance.

An immediate application of this argument to practical matters was of course not contemplated by the author. Dr. Donders need not be afraid that he will be "unmercifully condemned to death by hunger," which he represents as the result of Dr. Frerichs' idea. Even if it is proved correct, there remains to be solved before it is practically applicable this further most difficult question: viz. *In what form* the alimentary principles must be supplied so as to be capable of being made blood? Although a substance contains all the elementary atoms necessary to supply the waste of the body—carbon, hydrogen, nitrogen, sulphur, salts, water, and so on,—and at the same time is perfectly capable of absorption and conversion into blood, yet it does not follow that it is sufficient to sustain life. In fact, though it is capable of absorption it may be limited in capability as regards quantity; it may have the power of entering into assimilation only in a certain definite amount, and that amount may be more or less than sufficient for the wants of the organism. This seems to be the case with all the substances that form our aliments; pure albumen, pure gelatine, pure chondrine, cannot separately be taken up in sufficient quantity to sustain life, however much of them be passed through the alimentary canal. A combination of aliments is necessary, and what quantity of each is required to form the combination cannot be learnt by finding the amount of carbon, hydrogen, &c., which they jointly have contained.[*]

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[*] It is proper here to make a cursory mention of the division of aliments by Baron Liebig into supporters of respiratory combustion and replacers of tissues, into "fuel" and "building materials." The striking simplicity of the theory involved, so like one of the great laws of Nature, and the attractive style of the justly-honoured author, has made this classification very popular, and raised hopes that it would explain many things to which it is not applicable. But the fact is, it is not itself by any means tenable as a division. The building materials may be and are used as fuel, and the fuel as building materials. Flesh is to many carnivorous animals the only possible source of carbon, yet if anything has a title to be considered a pure replacer of tissue it is this substance. Oil is considered by Baron Liebig as fuel, and to justify this assumption he has to carry *à l'outrance* an unfortunate saying of John Hunter's, "that fat was no part of the animal body," to describe the tissues as "only mechanically infiltrated with oil

Perchance the time may come when we shall be able to deduce on purely scientific grounds, what the due admixture, and due quantity of such admixture should be to supply an animal with sufficient nutriment. Perchance it is not far distant, but it is certainly still future. As yet our only practicable means of coming to any conclusion on the point, is to take a typical article of food which we find by experience is capable of nourishing an animal for a considerable period, and to make that the measure of what is required by the organism. The article which answers our purpose best is of course that which is the sole supply of the animal for a definite portion of its life; a portion of its life too, when the processes of growth are necessarily more active than at any other time; when in fact it doubles, quadruples, or decuples the weight of each and all of its tissues on one food alone. Such a food is obviously a sufficient one, and we may fairly consider that it contains all the alimentary principles required for interstitial life. *Milk*, then, we will take as the type of a perfect aliment, and the principles contained therein--viz., the protein compounds, hydro-carbons, and oils (represented in milk by casein, sugar, butter), with water and salts—may be viewed as the only sorts of food neces-

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and water like a sponge," and to state that those constituents possess no "organic form, no vital characteristics." But what organic form would there be in the globe of the eye, what in the muscles even, without water? What would the brain and nerves, the very characterizers of vitality if anything is, what would they be without fat?—not nervous matter at all. Here at any rate fuel is used for building materials; and as other hydrocarbon seem capable of conversion into fat. they may become building materials too. Another objection to the theory is that it represents oxygen as an inimical power, a sort of destructive Ahriman, against whose invasions it is necessary to have a guard in these supporters of combustion—a fire which tends to burn our house down if we do not feed it with other prey. Whereas in fact oxygen is itself a building material; it unites with the albumen of the blood to form the fibrine of the muscles, the caseine of the yellow elastic tissue, the substance of the skin. &c., &c. So far from there being any real opposition between oxigenation and nutrition, it is itself nutrition. In fact, the only truth which the theory expresses is, that in proportion to the expenditure of carbon, so must be the supply of the same material in some form or other. Great and important this truth is; and perhaps it was right in Baron Liebig to call attention to it by such bold expressions as the calling animals "locomotive furnaces," and by the rough division of aliments above mentioned, but they must not be carried further than the intention of the original author, and applied to subject matters for which they are unfitted.

sary to pure existence. All these substances are found again, either in their original form or in one into which they are simply convertible; in some part of the body perform the duty of replacing continuously decaying organs, while the relics of the decomposed tissues which they replace form the excretions. On these substances, without any other, experience shows that life may be, and is, carried on in the greater part of the animal creation; they *fill up* the blanks occasioned by wear, and hence I have called them COMPLEMENTARY FOODS.

Not satisfied with these bare necessaries, we find that our species chiefly, but animals also to a certain extent, are inclined by a *soi-disant* instinct to feed on a variety of articles, the use of which cannot be explained as above; they cannot be refound in the organism, they cannot apparently, without complete disorganization, be employed to build up the body. Without compromising ourselves by prejudging any doubtful question, these may be considered as extra diet, or called, as they are in the division a few pages back, ACCESSORY FOODS. It is scarcely necessary to say that by this expression are meant alcohol, flavouring others, essential oils, perhaps gelatine tea, coffee, pepper, tobacco, spices, opium, &c., &c.; which are absolutely in themselves accessory. And there is also intended to be included the great excess above what is either to be found in our typical aliment or required to replace wear, which instinct leads us to consume of some substances absolutely speaking complementry, such as for example water and salt.

These are what man does not want, if the protracting from day to day his residence on earth be the sole object of his feeding. He could live without them, grow without them, think after a fashion without them—a baby does. Would he be wise to try and imitate it?

The answer to the foregoing question must lie first in accurate scientific observation of the true physiological effect of these substances on the human frame; and the knowledge thus gained must precede any balance of the advantages accruing from them, with their social and political results.

The distinction between accessory food and DRUGS is a line not easy to fix absolutely. It is a purely practical one, grounded on the experience, that while the former are designated by human instinct as good for the body, in either health or disease; the latter are only suited for it in the pathological condition. They tend to *disturb* the physiological processes under both circumstances; in the former it is generally not desirable that they should be disturbed, while in the latter such a disturbance is a necessary step to health. So that drugs might be called the accessory food of a pathological state.

SECTION I.—COMPLEMENTARY FOODS.

SECTION I. A.—*Complementary Foods capable of direct Absorption without Change.*

The most important of these is WATER, before described as passing backwards and forwards through the membranes, and which it is scarcely necessary to say is required to be present, not only in the fluctuating circulating condition, but fixed in all the tissues to secure their efficiency. It is essentially a part of the body, both during its stay there in the circulation by diffusion, as well as when united to other substances it builds up the form of the organism. The source of water to supply the loss by secretion is sufficiently obvious.

Of next importance to water is CHLORIDE OF SODIUM, which is found in the soluble ashes of all animal substances, and constitutes their chief bulk. It is in the blood proportioned to the other soluble mineral matters as 2·4 or 3 to 1. In the healthy state its quantity in the blood varies within but narrow limits, the analyses of Drs. Berzelius, Nasse, Marcet, Becquerel, Rodier, and those of Dr. Lehmann from an average of eleven observations on men and eight on women, keeping within the numbers above cited.* But in pathological conditions it is very various, showing the intimate relation it has as either cause or effect to the well-being of the individual. Cartilage is the solid part of the body that contains most chloride of sodium; in the soft bones of the fœtus it seems almost to take the place of phosphate of lime. In all exudations that show such a wonderful tendency to build themselves up into new and peculiar forms, in pus, in fibro-pus, in cancerous juice, there is a great abundance of this salt; indeed its presence seems to bear a close proportion to the amount of cell formation, either growing or capable of growing in the substance which contains it. Does not this indicate an alliance with nutrition of the closest kind?

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* Lehmann, *Physiolog. Chemie*, vol. 1., p. 441.

The increase in the solubility of albuminous matters which is caused by chloride of sodium, makes it a prime mover, next probably to water, in the great intermediate circulation by diffusion. As a constituent of the solvents of the alimentary canal, it carries in with it these important nutriments, preserves them fluid through the chyle and blood, then parting from them as they become fixed in the tissues, returns to perform the same round again.

The latter part of its journey is partly directly diffusive and partly metaphoric; the greater portion indeed of the salt coming out again in its own shape in the juices, but some being resolved into the hydrochloric acid of the gastric juice, and the soda of the bile and other secretions.

A direct proof of this latter expenditure of the chloride of sodium is afforded by an experiment on a dog performed by Dr. Bischoff. In twelve days the animal consumed 159 grammes of salt, but excreted by urine only 145 grammes, so that 14 grammes (nearly half an ounce avoirdupois) are not accounted for. Yet that amount was not fixed in the tissues, for the animal did not increase in weight. It is clear therefore, that over and above the quantity which replaced the same salt taken out of the tissues by destructive assimilation, a considerable allowance is decomposed in the body, and is either secreted or fixed in another form, its acid united to other bases, and its base in connexion with other acids.*

Like water, chloride of sodium is so universally diffused throughout nature, that it is impossible to select a diet which does not contain a considerable, though not perhaps always a fully sufficient, portion of it. Where it is wanting in the solid food, it is sure to be supplied by the water drank. Any albuminoid aliment which is deficient in this salt is tasteless from its want of solubility, and for the same reason is innutritious and useless. An instance of this, familiar to all, is the well-known want of flavour and digestibility in meat which has been long boiled, while the central parts of cooked joints are equally well-known to be the most sapid and nutritious, and the more so the less the fluids have been allowed to escape from them.

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* *Annalen der Chemie und Pharmacie*, lxxxviii., p. 109.

The researches of Baron Liebig (quoted in Dr. Lehmann's *Physiol. Chemie*, B. III. p. 91), show a very different proportion of sodium and potassium in the flesh of different animals. The

Gravy from	pike	contains to 100 parts	of soda,	497	of potass.
"	fowl	"	"	381	"
"	horse flesh	"	"	285	"
"	beef	"	"	275	"
"	fox	"	"	214	"

This may serve in some degree to explain their different value to the organism in health; but above all it may assist us in using them to avoid disease. Scurvy is caused in a great measure by the absence of the potash salt in the system, and a valuable suggestion towards the perfection of dietetics against that complaint seems afforded by the above observation. Should not fish and fowl, instead of beef, be used where there is danger, of its attacking a body of men submitted to our care?*

The value to the organism of the soluble PHOSPHATES OF

Substance.	Per-centage of salts soluble in water contained in the ashes.	Per-centage of soluble phosphates in soluble salts.	Form of soluble phosphate.
Blood of ox . . .	60·90	1·58	Tribasic phosphate of potass
Flesh of Horse . .	42·81	11·10 83·27	Bibasic phosphate of soda " " potass
Milk of cow . . .	34·17	21·60	Tribasic phosphate of potass
Yolk of egg . . .	40·95	24·57 25·16	Phosphate of potass " soda
White of egg . .	81·85	0	
Ox gall	90·85	6·78 14·51	Tribasic phosphate of potass " " soda
Urine (human) . .	90·87	16·12 4·55	Bibasic phosphate of potass Tribasic phosphate of potass
Fæces (human) . .	18·55	20·13	" " "

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* An economic observation may not be out of place here. Are manufacturers of prepared meats right in employing the same preparation for all sorts of flesh? Should not variations in the substances used be made according to the saline contents already existing?

SODA AND POTASH is shown by the great quantity of them contained in the ashes of animal matters. This is shown in the preceding table of analyses by Rose, given in Dr. Lehmann's *Physiological Chemistry.*[*]

The ample quantity of phosphatic soluble salts in the ashes of plants and their seeds, as well as in meat, leaves no doubt about the source of their supply to the organism under every modification of diet. The deficiency of phosphates observed by Berzelius in the flesh of young animals may perhaps account partly for its deficiency in nourishing power, which has been long suspected.

CARBONATE OF SODA has been conjectured to play in the blood a most important part, viz., of carrying from the capillaries to the lungs the carbonic acid which requires to be removed from the organism. It is supposed by Baron Liebig to leave the tissues as bicarbonate, to go to the lungs and part with one atom of its acid, and then be returned to pursue the same course. But this is little more than conjecture, for, as Dr. Lehmann pertinently remarks, there does not seem enough carbonate of soda in the blood to perform this great duty. Moreover its presence, separated from organic acids, has not been quite proved. However that may be, there is no difficulty in accounting for its supply in ordinary food, or from the decomposition in the body of kitchen salt.

The SULPHATES also may easily be supplied ready formed in the same way; but whether they are so in any degree, or whether the considerable quantity that may be detected in the fluids is derived solely from the decomposition of the sulphur-laden albumen and fibrine, is not ascertained.

The substances hitherto quoted are capable of immediate solution in water. Others are easily made soluble by the conditions in which the water exists in the circulation. It is, for instance, largely impregnated with carbonic acid by the magazine of that gas which is in the bowels. Hence the PHOSPHATE OF LIME and the CARBONATE OF LIME so necessary to the solid structures, are rendered capable of being taken up in a fluid form. The seeds we eat and the water we drink are the most generally used articles of food containing them. IRON is probably taken up in the same way to supply the blood with hæmatin, for the soluble salt of iron formed by the hydrochloric acid of the stomach is quickly thrown down again by the alkaline secretions it soon meets. These may be described as made soluble in water by the carbonic acid it contains.

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[*] Vol. i., p. 451.

The absorption of OLEAGINOUS SUBSTANCES has been so thoroughly discussed in a former chapter (page 102), that no wonder will be expressed at seeing them included here among matters which are absorbed unchanged. Those who hold that a saponified condition of fat is necessary for its passage through the membrane, do not suppose any change to take place beyond the union with an alkali, to be dissolved again in the lymphatics; and those who would resolve the neutral oil into an acid and base, do not object to a similarly rapid reunion. At the same time the former mention of the substance was so full as to render superfluous anything beyond a reference to those pages.

It might however appear at first sight that fat and several substances to be shortly named ought to form a distinct class, as being liable to change in the intestinal canal. It may be stated truly enough that butyric acid, &c., usually form in the stomach, and are probably capable of absorption.

But this is not *in consequence*, nay I do not know whether it may not be said to be *in spite*, of the digestive juices. The same amount of warmth and shaking, with the presence of fermenting organic matter, would probably more quickly produce the same decomposition out of the body. It is not a part of digestion, but an impediment to it. This has been made sufficiently evident by the already quoted experiments of Drs. Bidder and Schmidt on the gastric juice (page 93, Question 4).

The great quantity of fat present throughout the body, increasing its efficiency, making more easy its motions, adding to its beauty, and forming a component part of the prime material means of communication between mind and matter by being a necessary constituent of brain and nerve, shows sufficient cause for its being a complementary food. Its importance is shown by the quantity afforded in milk to the young animal: it is easier digested than other hydro-carbons, which as regards respiration may be classed with it, and therefore is preferable for that period of existence when a full allowance of such food is desirable. In the food eaten in later life it is also largely present, and is instinctively viewed by all nations as an object to be sought for. It is associated in all languages with ideas of luxury from the earliest ages. The "butter and honey" of the prophet, used as a phrase for royal food, and the reference in almost every second page in the Bible to oil as a source of riches (though it could have been no *rarity* in a country peculiarly described as a "land of oil olive"), are sufficient to show its estimation among the ancient Orientals; while in the present day the Hindoo sepoy, when he devours his gallon of rice at a meal, will spend all the pice he can get on the clarified butter of the country, and "as good as ghee" is his expression of unqualified praise. It was an error in Dr. Liebig to state that oily foods are an object of disgust to nations of warm climates; all races of man require them and seek after them; and the habits of the Esquimaux, so often quoted, probably depend on the abundant supply of the article which the sea places at his disposal, coupled with a scantiness of other provisions, more than on the instinct of taking "respiratory" aliment. Throughout the globe there is a craving for fat in some form, varying according to the climate, because experience shows one form more than another to be subject to decomposition under particular circumstances; varying also according to climate as the cause of its production in one or another shape.

SUGAR, like fat, has already been made a subject of comment, both in the chapter on Absorption in the Small Intestines (page 107), where Dr. Bernard's observations are detailed, stating his belief that it is taken up unchanged by the portal veins, corrected by the further observations of Dr. Lehmann, and also in the sections on the Convertive Actions of the Saliva and Pancreatic Juice (pages 63, 127), where it is shown to be formed in very large quantities from the starch used as food. The present state of our knowledge may be shortly stated thus:

Sugar is taken in considerable quantities, and indeed is not absent from any wholesome diet, so as to be fairly classed as a complementary food;

It is formed from the amylaceous aliments, and this metamorphosis is a necessary step in their digestion;

The change of amylaceous matters into sugar commences instantaneously after their reception into the mouth, and goes on continuously in the digestive canal;

That a small quantity of sugar is taken up as sugar by the veins and lacteals is probable, that the whole is so taken up is improbable;

That it is *largely* converted into lactic acid in the healthy digestive canal is improbable, from the rarity of acid reaction in the examination of its contents.

The farther conversion of lactic acid into butyric is possible, but cannot be traced in the blood or chyle.

No more is necessary to show the extremely unsatisfactory state of the question at present.

The conversion of lactic acid into butyric acid has not been before alluded to, so a few sentences may fairly be appropriated to it. It is in truth part of a theoretical mode of accounting for the formation of fat in the body, and is expressed in the following formula:—

$$\left.\begin{array}{l}\text{Hydrate of lactic}\\ \text{acid}\end{array}\right\} = \left.\begin{array}{l}\text{hydrate of butyric}\\ \text{acid}\end{array}\right\} + \text{carbonic acid} + \text{hydrogen}$$

$$2\,(C^6H^5O^5 + HO) = (C^8H^7O^3 + HO) + 4\,CO^2 \qquad + 4\,H$$

That is to say that hydrate of lactic acid may, by parting with carbonic acid and hydrogen, become butyric acid. Now the formation of these two gases in considerable quantity in the bowels is a fair argument that such a conversion does take place, and the finding also frequently of butyric acid in the cæcum is an additional one; but whether it is the natural course of things, still more whether it is necessary to absorption, must remain at present undecided.[*]

The fact of the existence in milk of such a large proportion of a form of sugar is a sufficient proof that it is easy of appropriation by the digestive canal, when presented to it in a suitable combination. There is reason to believe that the lactic acid which it is converted into is an aid to the solution in the stomach of albuminous matter, and that, therefore, if allowed fair play, it is not only digestible itself, but a cause of digestion also.

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[*] *Engelhardt* und *Madrell;* quoted by Dr. Donders, *Nahrungsstoffe*, p. 102.

SECTION I. B.—*Complementary Foods capable of Absorption only after Previous Change by the Digestive Juices.*

STARCH.

In its original condition, either raw or when broken up by boiling, it does not appear that starch is capable of being absorbed by the alimentary canal. But we have already seen (page 63,) how on its first introduction to the mouth it meets with a fluid capable of converting it into one of the most absorbable of solid substances, and how the metamorphic influence of the saliva is continued till it is reinforced by the pancreatic juice (pages 71, 94, and 127) and is aided by all the animal tissues and juices to a certain extent (page 65). This conversion into sugar makes it into a complementary food duly represented in our typical diet, milk, by its peculiar form of saccharine matter "sugar of milk."

In the physiological part of this volume, then, it is clear that the chief point of consideration respecting starch is the best mode of offering facilities for this conversion into sugar, by which alone it can become a useful aliment. And a collateral subject of inquiry will be the effect of its remaining unchanged, or the chance of any improper decomposition.

Starch when raw is a very solid indigestible body, for it is surrounded by an envelope of cellulose, very thin indeed, but quite insoluble. Heat cracks this, and then nearly all the substance unites with water, and forms, if there be sufficient water, the well-known slimy fluid. Cookery then is of the utmost importance to its digestion; and we should take care that amylaceous victuals are not only exposed to fire externally, but heated thoroughly and equally, and not covered up in any insoluble substance. Slow cookery is therefore for them the most wholesome and economical, and in proportion as the food is starchy, so should the heat be gradual and long continued. Potatoes, for example, steamed or roasted, or if boiled mashed so as to extract all hard lumps, are in the best condition for digestion. Frying them, toasting them, baking them, or browning the surface again dries up the starch into a hard half charcoaly mass, which except in most powerful stomachs, must act as a foreign body.

At the same time it must be remembered that starch has to be acted upon immediately on its entrance into the mouth, and that chewing is of importance not only to its mechanical division, but to its chemical solution. For this reason some solutions of starch usually considered invalid dishes, such as arrowroot, gruel and the like, disagree with persons who do not easily secrete saliva; they descend unmixed with buccal fluid, and are not converted into sugar till they get to the duodenum. Those who have injured the sensibility of their salivary glands by smoking tobacco, are very apt to complain of this circumstance, and to wonder why such simple food lies like a weight in their epigastrium. Starch then in a solid form, such as in bread or potatoes, for instance, is more easily digestible than when fluid.

A familiar example of the mechanical differences in the form of starchy food, are the two sorts of piecrust known as "short" and "puff" paste; in the former, the butter is thoroughly incorporated with the dough, so as to divide the starch granules one from another, and permeate the gluten like a sponge; while in puff pastry the dough forms thin but solid layers, like a quire of buttered paper. If the teeth are imperfect or mastication careless, the latter is well known to form in the stomach a solid mass, which is difficult of solution in the upper part of the intestines; whilst the easily-broken paste (the "short") is mixed with the rest of the food, and if the butter is fresh, receives a very different character from its employer.

Starch as an unconverted foreign body passes in considerable quantities through the bowels. It may be found almost always by the microscope in the stools of diarrhœa or dyspepsia. But its effects as a foreign body seem to be not always identical. If it is in lumps it certainly seems to act sometimes as a hastener of the transit of the alimentary mass; and diarrhœa is the consequence, as happens in the case of ill-baked pastry; but when in a slimy state, or even if in a fine powder, as when uncooked, it shields the mucous surface from the action of the contents of the canal. Now in ordinary health this is not desirable—the more the aliments are exposed to the membrane the better; but in the pathological condition, when the secretions, or substances decomposed by them, are irritating and noxious, a slimy solution of starch may envelope them, defend the sensitive or wounded membrane, and so stop an existing diarrhœa.

To decompositions chemically injurious, starch does not seem to be liable; it does not, like albuminous food, generate sulphuretted hydrogen or any other poisonous gases; but at the worst only causes a stomach-ache by an excess of lactic or butyric acid in the stomach or colon.

ALBUMEN AND ALBUMINIZED SUBSTANCES.

The subject of the normal digestion of albuminoid substances has been already fully discussed in the section on the Gastric Juice (Chap. IV. § IV. F.). It is obvious from thence that they are to a person in health the most easily assimilated and most wholesome of nutriments. So acknowledged is this importance by the general consent of mankind, that the different classes of complementary victuals producible on a large scale command a price very closely proportioned to the quantity of albuminoid matters they contain. Butcher's meat, fish, cheese, corn, cabbage, potatoes, rice, would be the order in which the average commercial value of the articles named would stand in an universal market, and it is the order of their richness in fibrine, albumen, casein, gluten, &c., or similar allied principles. The most useful field open for science in this quarter of knowledge would be to estimate the circumstances under which one form more than the other is more easily or completely convertible into blood, and its consequent value to the healthy digestion.

The great aid to the rapid conversion of albuminoids into the state of peptone* in which they are absorbed, is softness and permeability by water, so that the converting juice may have access to every particle as soon as possible. The mechanical condition, as it is sometimes called, of these nitrogenous aliments is of twofold more importance than the quantity of nitrogen they contain. If enveloped in an insoluble layer of their own or other substance, they are in fact as useless as gold locked up in a box, for "paullum sepultæ distat inertiæ Celata virtus."

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* See Chap. IV., p. 89.

But we cannot satisfy ourselves with merely a roughly estimated condition of softness; a general state of pulp is in fact not inconsistent with great difficulty of solution, arising from minute fractions of the substance being insoluble. The separate parts may be like fine shot, less inconvenient but nearly as unmanageable as a lump of lead.

The microscope may be brought into play here with advantage in two ways. In the first place the state of the food may be examined previous to its being eaten, and so a knowledge obtained of the mechanical alterations effected by various modes of preparation. Secondly, it may be examined in the several stages of digestion. Observations on the fæces, which to the microscopic eye present nothing repulsive, and may be placed under view in such small quantities as nowise to affect the nose, are a most important road to knowledge, as yet little walked in.

The influence of cookery on albuminoid substances is a subject of greater importance even than its effects on starch, whether looked at from a purely philanthropic, economical, or curative point of view. The experience of the *artiste* on this subject is often of more importance than that of the philosopher, because the latter has been apt to consider solely the *chemical* part of the operation, somewhat to the exclusion of the *mechanical;* while the former, by considering neither, avoids that partial truth which is the parent of all error.

Examples of the importance of these mechanical changes effected by various modes of applying heat may be found in our common methods of cookery.

They are judiciously combined with chemical influences in the British operation of *roasting* a joint. The heat radiated from the open range coagulates the outer layer of albumen, and thus the exit of that which is still fluid is prevented, and it becomes solidified very slowly, if at all. The areolar tissue which unites the muscular fibres is converted by gradual heat into gelatine,* and is retained in the centre of the mass in a form ready for solution. At the same time the fibrine and albumen take on, according to Dr. Mulder,* a form more highly oxidized and, especially in the case of the former, more capable of solution in water. The fat also is melted out of the fat cells, and is partially combined with the alkali from the serum of the blood. Thus the external layer of albumen becomes a sort of box, which keeps together the important parts of the dish till they have undergone the desirable modification by slow heat—a box, however, permeable in some degree by the oxygen of the free surrounding air, so that most of the empyreumatic oils and products of dry distillation are carried off. These are doubtless in a general way no loss to our stomachs or our palates. If acetic acid be generated it is probably carried off, and if not carried off it is neutralized by the alkaline carbonates, as certainly roast meat is not acid to test-paper if quite fresh. The little that may remain would not disagree, and would probably render the muscular fibre more soluble.

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* Not however the sarcolemma, which an experiment of Professor Kölliker's

Rapid boiling may effect in some minor degree the case-hardening of the meat above described, but the interior albumen seems by this process more hardened and less digestible, perhaps from want of the acid above named.

Slow boiling makes, it is true, a nourishing soup, but converts the muscular fibre into a mass of hard strings, which, eaten or not eaten, are in nine cases out of ten equally wasted. These are to be found in the fæces exhibiting all the beautiful transverse striæ of their original state, quite unaffected by their intestinal journey.

The utility of *soups* and *broths* depends on several circumstances, which modify a good deal the advantages accruing from their liquid state. Heats seems to have an effect on albumen in some degree proportioned to the period of its application, rendering it more or less insoluble, at the same time that to a delicate palate there is a decided loss of savour. Thus soups and stews which are "kept hot" are wholesome enough during the first few hours, *may* be digested at a railway refresh-

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seems to remove from the class of substances yielding gelatine. See Kölliker's *Mikros. Anat.*, vol. ii., p. 250.

* Quoted in Moleschott's *Diätetik*, p. 450.

ment room for some hours after, but on the second or third day give the incautious eater of Palais Royal two-franc dinners an infallible diarrhœa. Though finely divided, the minute fragments of muscular fibre seem to be individually rendered insoluble.

Stewing and *baking without free air* retain truly all the good things in the dish, but they also retain a variety of known and unknown educts of dry distillation, organic empyreumatic oils and acids inimical to the stomach's peace. They require therefore much care, and are as a rule not advisable to be undertaken on a large scale.

Roasting therefore is as scientific and wholesome, and *therefore as economical* a process as it is a palatable one, and is well worth the extra expenditure of fuel which is entailed.

With regard to the amount of chewing required by flesh and other albuminous food, there is a good deal of popular misconception. Persons with bad, false, or tender teeth are often found to fancy that a vegetable diet is more suited to their imperfect powers of mastication than an animal one; and we not unfrequently see mothers instructing most carefully their children to chew well their meat, and neglecting the same precaution in respect of vegetables. The physiology of the mouth and stomach, and the relation in which they stand to albuminous and starchy food respectively, teaches us to act in a completely opposite way. It is desirable indeed that the jaws should break up muscular fibre as much as possible, in order that it may be easily permeated by the gastric juice as soon as it reaches the stomach. But to vegetable aliments they owe still more important duties. It is equally indispensable that they should be broken up, and it is also required that they should be detained in the mouth till enough saliva has been secreted and intermixed to turn them into sugar. Mastication therefore, important for both, is more indispensable for vegetable than for animal food.

On the whole it appears that more light will be thrown on the subject of the different degrees of digestibility and true commercial value of various meats and dishes from a consideration of their mechanical than of their chemical forms; for the nutritive powers of food are not simply in proportion to the quantity they contain of the elements of the blood, but of the quantity *in a state capable of assimilation.*

The idea of estimating the value of food by the quantity of nitrogen it contains is a most fallacious one. This is clear from the analyses by Drs. Schlossberger and Kemp, quoted in the third volume of Dr. Lehmann's "Physiological Chemistry." From these it appears—

> "That the amount of nitrogen in muscular fibre throughout the animal kingdom is essentially the same. The flesh of fish contains the same total quantity of this important element of nutrition as that of the higher animals; oysters, on the other hand, instead of containing more, as experience of their utility would lead us to conjecture, actually stand lower down in the scale of proportion. So there is a striking difference between being rich in alimentary principles and good for food."

Besides the necessity for being in a condition capable of solution, it is probable that there is also required a certain combination of the complementary principles among themselves, and that on the approach to perfection in this combination the value of food depends. The complementary diet must contain all the constituents of the body, and we may feel sure that such diet will be most suitable which contains these constituents as nearly as possible in the proportions and combinations required by the body to be nourished.

The variation to be made in the complementary diet according to the circumstances of the individual, depends on the peculiar waste which those circumstances cause. We see a typical food supplied by Nature to the young of our race, containing, floating or dissolved in its copious water, 10 parts of plastic material or albuminoid matter, 10 parts of fat, 20 parts of sugar, and 0·6 of salts.* At this period of life the whole duty of man consists in growing big and strong, and unquestionably that diet enables him to do it better than any other. But then this golden age has an end, other functions and other duties arise; the outer world makes its demands, mental and bodily deeds have to be done, and therefore a different expenditure and a different income must be calculated upon.

And as the circumstances of adults are more varied than those of infants, so must their diet be made various too, not by eating a number of things at once, but by changing the nature of the things taken, according to the changed requirements of the system.

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* Lehmann's *Phys. Chemie.*

Thus there is no question but that easily assimilable brown meat is the proper food for those whose muscular system is subjected to the waste arising from hard exercise. And if plenty of it is to be got, and the digestive organs are in sufficiently good order to absorb enough to supply the demand, it completely covers the deficiency. Water under these circumstances is the best drink, and a "total abstainer," with plenty of fresh meat, strong exercise, and a vigorous digestion, will probably equal anybody in muscular development. But should the digestion not be in such a typical condition, should the exercise be over severe, and the victuals deficient, then the waste must be limited, as we shall shortly see, by alcohol or some similar arrester of metamorphosis; if it is not, the system suffers, and the man is what is called "overworked."

The influence of diet over muscular fibre is an important social question, for thews and sinews have always ruled the world in peace and war in a proportion quite equal to brains. Indeed it is a question which the present writer is disposed to answer in the affirmative, whether, *nationally*, muscular and mental energy do not always run in couples, and whether the first is not the cause of the second. It does not appear that any diet, so there be plenty of it, is incapable of fitting a man to get through his daily work *in a fashion;* but the *best* specimens of the species in their several sorts, hunters, agriculturists, or citizens, are those nations which get most flesh meat.*

Intellectual labour also exercises the demand for food, and at the same time unfortunately injures the assimilating organs; so that unless a judicious diet is employed, waste occurs which cannot be replaced. The best way for studious persons to avoid this evil is to eat little at a time, but often, and to let the diet be compact and easily assimilated, such as fresh made soups, bread, and small quantities of meat. There cannot be a more injurious habit than that of working long at mental labour, till the body is exhausted by the waste, and then engorging the heavy meal to which the false appetite gives a temptation. It cannot be digested aright, and the body, though with plenty inside it, pines away unsatisfied.

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* A collateral advantage of meat diet to a nation is the difficulty of obtaining it; for the truth probably is that the mode of procuring food has as great an influence over mind, manners, and muscles as the nature of the food itself. He that is satisfied with what he can pick up ready-grown degenerates either into a starved New Hollander, where food is deficient, or into an effeminate creature like the old inhabitants of the West Indies where it is abundant; while a civilized people, with a "care for their meat and diet," will have thought about it, laboured for it steadily, advanced science and ransacked Nature to improve it, and obtained their reward in the search itself.

There is one occasion when a great temporary increase in a peculiar secretion is required by circumstances; viz., when the mother supplies food to her infant. It is singular to see the neglect of the common-sense expedient of promoting this secretion by supplying the very substance it drains off from the body. Nursing women are desired to drink an unusual quantity of porter, wine, bitters and what not, till they get bloated, thick complexioned, stupid and dyspeptic. The reason of this will be explained when we come to see that alcohol and other ingredients in such a diet arrest metamorphosis, detain in the system the secretions we want to flow out, and fill those which do flow out with effete matter. If the constitution of the mother is robust enough to stand this bad usage, and still afford the full quantum of milk for her child, yet that must be of inferior quality to what she otherwise would have made, and the innocent consumer suffers. Perhaps it does no further harm than making the baby sick, but still that might just as well be avoided. Let the same woman adopt a full milk diet, correcting if necessary its tendency to turn sour by some mild alkalies—such as one-fourth of its bulk of soda-water—and a change for the better will be immediate: it is beautiful to watch the increased softness and smoothness of skin, the plumpness and invigorated muscular power, which follow such a simple obedience to the laws of common sense.

To reduce the diet so as to accustom the stomach to take only just enough to supply the ordinary waste, is not wise. The well known Venetian, Luigi Cornaro, did this, and published his experience. He lived indeed to a great age, but then he passed a sort of vegetable life in his palace and his gondola which would be intolerable to us Saxons. Dr. Clark tried similar experiments, and got on pretty well so long as he had nothing to do beside weighing himself, but when he came to undergo a contested election for St. George's Hospital it killed him outright,* as it would have done Cornaro, Hilarion, Simeon Stylites, or any other hero of asceticism. If the body is to be exposed, as it is in all modern civilized life, to sudden extraordinary demands, it must be prepared for them by being habituated to take in rather more than is ordinarily required.

Another condition requiring a decidedly accessory amount of flesh diet to retain health, is the deprivation of light and pure air. The inhabitants of towns and city artisans require more meat than country labourers: if they get it they keep well; if not, they deteriorate in their own persons, and produce a still worse offspring. A striking instance of the advantage of a full animal diet is afforded by the Yorkshire colliers. They work as a rule longer hours and (according to the report of Mr. Mackworth, inspector of mines†) in worse ventilated pits than in Belgium, yet they are generally hearty and strong, suffering more from accident than disease; while among the Walloon miners about Liege there is endemic a peculiar anæmia, of such a well-marked character that the inspecting surgeon can immediately detect, by the waxy complexion and deficiency of circulation, if they come from a badly ventilated mine. This prevalence of an endemic among a class of men peculiarly cared for by the paternal eye of their government, and its absence among Englishmen left to take care of themselves perhaps too much, is explained by the diet of the former. It is sufficient indeed for a Flemish day labourer, but quite inadequate for a miner, consisting week after week of coffee and bread and butter, rarely of meat, and scarce any soup,‡ while the Yorkshireman luxuriates in at least one and often two hearty meals of flesh meat daily. With this excess of victuals they are able in a great measure to resist the noxious circumstances in which they are placed.

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* The last few entries in Dr. Stark's Journal, continued nearly to the day of his death, have a melancholy interest. He was truly a martyr to science.

† *Journal of Society of Arts*, April 7th, 1855.

‡ *Revue des Deux Mondes*, 15 Mars, 1855, page 1207.

SECTION II.—ACCESSORY FOODS.

SECTION II. A.—*Accessory Foods capable of Absorption without the agency of the Digestive Juices.*

a.—INCREASERS OF METAMORPHOSIS.

WATER and KITCHEN SALT, when they exceed in quantity what is requisite to supply the waste of tissue and the requirements of the immediate circulation[*] occupy the part of accessory food.[†] In the first place they render the various articles of diet more soluble and so more absorbable, and secondly they act by some unknown agency on nutrition, rendering it more complete and normal when they are supplied in full measure than when they are scanty.

The solvent powers of water are too familiar and proverbial to need illustration, but its further influence over nutrition has only lately been scientifically investigated, and may therefore probably be made the subject of attention. The observations of Dr. Böcker of Bonn, on his own person, exhibit this in a most lucid manner.[‡] The experimenter appears to have used the utmost precision, and details so conscientiously the mode adopted of making his estimates, that additional knowledge may perhaps alter the conclusions drawn, but can never diminish the value of the experiments. After he had determined by some preliminary trials what quantity of food and drink was just enough to satiate his appetite without causing loss of weight to his body—that is to say, was sufficient to cover exactly the necessary outgoings of the organism—he proceeded to special experiments, in which during periods of twenty-four hours, he took the amount of victuals ascertained by the former trials. The result was that on those days when he drank an increased measure of water the hitherto sufficiency of nourishment was not enough to cover his necessary loss by urine and fæces, so that the weight of the body constantly diminished.

The special experiments are in two sets. The first set extend over seven days, in each of which the observer took on an average 1260 grammes (2·66 pints) of water; the second set, also over seven days, in which he took 3360 grammes (7·11 pints) of water. The urine made during the twenty-four hours was collected as follows:—

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[*] See page 37.

[†] See page 156.

[‡] *Einfluss des Wassers.* Von Böcker. "Zeitschrift der K. K. Gesellschaft der Aertze zu Wien," April, 1854.

It was passed on first rising in the morning, and to it was added all that was secreted up to the same hour on the day succeeding, and then weighed and analysed. After emptying the bladder he took his weight naked, and repeated the weighing at definite periods during the day, allowing for the ingesta. The amount also of solid matter and liquid in the fæces was directly weighed, and the insensible perspiration estimated.

The result of these two series of experiments exhibited the following mean numbers:

	In the first series with 1260 grammes of water	In the second series with 3360 grammes of water
the daily exercise amounted to	84·14 minutes,	90·14 minutes,
and the daily loss of weight to be replaced by food was	539 grammes.	834 grammes.
The fæces daily excreted amounted to	178·3 grammes;	219·5 grammes;
of which the water was	129·6 grammes,	170·5 grammes,
and the solid portion	48·7 grammes.	49·0 grammes.
The urine daily excreted amounted to	2621·143 grammes.	4994·000 grammes.

He felt on the days when the larger quantity of water was taken more desire for food, and more languor after exercise, although, as may be seen, it exceeded by six minutes only that which was used on other days, but does not mention having experienced any other subjective change.

These experiments have been since confirmed by some made upon himself by Dr. Falck,[*] in which a progressive though not proportionate increase in solids excreted may be observed to follow the augmented amount of water drank.

	At the commencement of each period of 12 hours he took—			In each 12 hours he excreted—		
	Bread in grammes.	Pudding in grammes.	Water in grammes.	Urine in grammes.	Solids of urine in grammes.	Water of urine in grammes.
1	500	164	...	332	19·56	312·48
2	500	161	1000	489	27·18	461·81
3	500	165	2000	1310	27·24	1283·75
4	500	165	4000	3911	33·47	3877·52

The result of these experiments may be condensed as follows:

1. Water increases interstitial metamorphosis or destruction of tissue, and consequent loss of weight.

2. The decomposed tissue is excreted partly by urine and partly in solid fæces.

3. The water formed in the organism by metamorphosis of tissue is augmented, as well as the nitrogenous constituents of the excretions.[†]

4. The excretion of carbon by the lungs, the quickness of pulse or of respiration, is not affected.

5. A necessity for food, as exhibited in the sensation of hunger, keeps pace with the metamorphosis of tissue.

The increased rapidity in the metamorphosis of the solid parts of the body, from the use of a quantity of water exceeding that which the thirst and necessary excretions demand, is a most important fact. Its full application belongs to our reflections on medicinal discipline for abnormal states of body, but yet as an accessory food for the healthy it should not be passed over. Metamorphosis of tissue is *life*, or an inseparable part of life; and there is reason to believe that where it goes on quickly, and there is the possibility of a supply of new matter equal to the exhaustion of the old, the tissue changed is in a more perfect state, more able to resist external noxious influences, and therefore more likely to last long, than when the exchange is slow. When then, a man is able to get as much as he wants to eat, is able to carry it without inconvenience in his alimentary canal, and to absorb it to an indefinite amount, the extra quantity of water is wisdom on his part, for it makes him more lively and active. But not all are habitually in this typical condition; to many of our readers the latter clauses are probably unattainable —an extra quantity of food is a trouble to them, and the absorption of it painful or impossible; while those who mix much with the masses of their fellow-countrymen find a large multitude whose social circumstances prevent the fulfilment of the first requirement, and whose supply of food is sadly limited both in quantity and qualify. To all of these, an extra allowance of water is an extravagance which can only occasionally be advised.

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[*] Vierordt's *Archiv.*, i., p. 150. 1851.

[†] It will be seen by the table above, that on the full water days 4994+170 grammes are excreted, being an excess of 1804 grammes over the quantity drunk; whereas on the ordinary water days 2621+129, being an excess of 1490 over the quantity drunk. The quantity of water, however in the solid food, which of course constitutes some of the excess of secretion, was the same under both circumstances.

The power, analagous to that of water, possessed by KITCHEN SALT of assisting nutrition through its influence over the destruction and removal of effete tissues, is worthy of much attention. In a paper published by Dr. Bischoff of Giessen,* corrective and explanatory of parts of his "*Harnstoff als Maass des Stoffwechsels*," he has detailed the results of some experiments on the amount of urea excreted by a dog. Now the amount of urea excreted, though not indeed an absolutely exact measure of the metaphoric actions of the solid tissues, is an approach to it, and at any rate may be safely employed as a rough means of comparing the vigour of such actions under otherwise corresponding circumstances.† From these experiments it appears that the increased quantity from the use of chloride of sodium is indubitable, though not so great as by an error in calculation was stated in the work named. A dog taking daily a pound of beef without salt excreted 22·50 grammes of urea; with a solution of salt to drink he excreted 28·34 grammes daily.

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* *Annalen der Chemie und Pharmacie*, lxxxviii. p. 109.

† For the discussion of this question see *Medico-Chirurgical Review* for April, 1854, in an article reviewing Dr. Bischoff's work.

With respect to the urea being taken as a test of metamorphosis, it is to be remarked that it is probably a fair comparative, but not an absolute measure. The above-named dog, for example, took 6000 grammes of flesh in eleven days, containing 180·60 grammes of nitrogen; the urine excreted contained but 159·20 grammes of nitrogen, so that 21·40 grammes are unaccounted for, and must be got rid of in other ways, for the animal did not increase in weight.

The salt also, as elsewhere remarked, is not all excreted by the kidneys. The dog took 158·82 grammes of chloride of sodium, and passed in urine 145 grammes, so that 13·82 remain to be accounted for, being probably decomposed in the organism, the chlorine being united to other bases, and the sodium to other acids.*

Now solely on this information we should not know whether the final result of taking an accessory quantity of salt was injurious or beneficial. It might appear at first sight only to have an exhaustive interference, taking away that which it must require an effort of the organism to replace. But it must be remembered that it is in that effort that life consists, and that within the bounds of health the more metamorphic action there is going on, the more truly a tissue may be said to live, the more perfect it is and is likely to become. So that we may on these grounds rather anticipate an augmented efficiency, and a nearer approach to typical perfection from this increased action, in the same way as a muscle grows by fair use. Such hope seems confirmed by some experiments noticed in a former chapter, in which from the continued use of more than ordinary doses of salt the red globules of a healthy man's blood were decidedly increased in number, as well as the fat and fibrine, so much so indeed that the proportion of water sank from 779·92 parts in 1000 to 767·60.†

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* *Annalen der Chemie und Pharmacie*, lxxxviii, p. 109.

† See page 25 of this volume.

The employment of salt, therefore, in the average healthy state, is decidedly beneficial to the human species, and the use of it as an accessory aliment is wise in those who are well supplied with other food.

Empirical observation has long acted on this principle, and added salt to the fodder of domestic animals with the view of improving their condition; but inasmuch as some expense is involved in this custom, a question has arisen, whether it really is of any use or not? M. Boussingault tried lately a series of experiments on steers, which certainly lead to the conclusion that it in no way contributed to their condition.* And another set of trials has been made on cavalry horses in France, with a similar conclusion.† The horses in prime condition were not improved in appearance, and the thin ill-conditioned ones were rather deteriorated by the use of the salt. With regard however to these experiments, it is to be observed first, that they were made with *hay*, which already contains a good deal of salt, and do not therefore militate against its economical employment with other sorts of fodder. Secondly, they simply show that under *some* circumstances sickly animals are not benefited by this food. And thirdly, they do not show that the healthy ones were unimproved; for though no external signs of such improvement existed, it might possibly be found by analysis of the blood, as in M. Poggiale's case before mentioned.‡

The physiological actions of salt indeed lead us to expect that it must be hurtful in some cases. Where waste is already excessive, or under circumstances where the diet is insufficient, the advantage of salt is a matter of serious doubt. Where from poverty not enough to supply waste can be obtained, or where from an abnormal state of the alimentary canal or other causes that required amount is not absorbed, though abundance may be submitted to the mucous membrane, it can hardly be desirable that the destruction of the tissues it entails should be encouraged. It is a commendable thing that a man of good fortune should lay it out in building a handsome house, but if his income is limited he must limit even his praiseworthy expenditure. The latter event—pathological poverty as it may be called—belongs to a more advanced stage of the subject, but the equal importance of the other demands that it should not escape notice. Where food is deficient in quantity or quality, it is evidently improper that any excess of salt should be used beyond that which is just sufficient to act as a complementary aliment; all beyond this increases the waste. Encouragement should be given to employ instead other spicy flavourings which have not this tendency, or which have even a contrary tendency, as we shall presently see reason to believe is the case with several accessory aliments.

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* *Annales de Chemie et de Physique*, 1847, p. 117 et seq.

† *Recueil de Mémoires et Observations sur l'Hygiène et la Médicine Vétérinaries Militaires*, tom. iii., p. 509. 1851.

‡ See page 25.

It is to be remarked that the question of the use of salt as an accessory food is by no means the same as that of the employment of salted provisions. The manufacturing process so dries up and hardens the muscular fibre that without diligent cookery it is insoluble in the gastric juice, and in point of fact is an insufficient nutriment, a state of things where it has been said salt is improper. When salted provisions *must* be used, the desideratum is a mode of cookery which would render the albumen and fibrine again soluble.

β.—ARRESTERS OF METAMORPHOSIS.

The next accessory article of diet that will be mentioned is one that has exceeded in interest all the rest put together. **Alcohol** has attracted the attention from the earliest times—of the poet, whose business it is to record all that powerfully influences mankind,—of the philosopher, who explains the reasons of this influence; of the moralist, the physician, and the legislator, who argue out severally the consequences to man's mind, body, and worldly estate.

It is of course not our business here to enter into these questions; all we have to do with is the effect of alcohol on the healthy animal body, and in the Second Book on the sickly body.

But remembering how moral and theological considerations have been brought to bear upon it, we must be careful not to approach the subject in an ascetic spirit; we must avoid not only the spite of a St. Hilarion trying to bully the flesh, but also the refined affections of a Fra Angelico, dreaming in his cloister garden, and peopling his holy canvas with the abstract world his soul lived in. We must have a hearty sympathy for all that is human, yea fleshly, so it be not sinful. We must look upon everything which, without shortening existence, makes the sentient nerves of an individual feel pleasure, as in itself a positive good, therefore rationally to be sought for, therefore *natural* to a creature whose most normal state is the highest exercise of his reason.

The more means of corporeal enjoyment are placed within a man's reach, the more likely his mind is to acquire its noblest and most truly manly qualities; self-denial even, and the hardier virtues are of stronger growth, from having more opportunities for their exercise. Experience shows them developed in the civilized nation, not in the savage. The greater the perfection of the body, the better instrument the soul has to use; and physiology, experience, and everything else shows us that an animal attains the greatest perfection when it feels the least pain, and the greatest sum total of pleasure. That legislature then is truly patriotic which places within the reach of their countrymen the opportunity of gratifying the senses to the greatest possible amount without consequent pain. There is every reason to believe that by so doing they are making them bigger, stronger, braver, and more sensible. Although these physiologists should never be able to show that the gifts of Bacchus, or "the cup which cheers but not inebriates," the unaccountable quantity of salt men and animals take when they can get it, and similar accessories act as nourishment, though it should be proved that they *do not* act as nourishment, still we have a means of accounting for the indubitable fact that the opportunity for temperately enjoying them has always coincided with the advance of a nation in the scale of humanity. And that, on the other hand, some declines and falls have singularly accompanied the surrender of wholesome fermented liquids. Why were the Egyptians great when beer was the popular drink, and why have they become "no nation" since it has ceased to be so? Is the degradation of Asia Minor and

Arabia quite irrespective of the Moslem denial of wine to the best, that is the conscientious citizens? There is reason to believe that an historian who would take up this subject, would be able to connect advance and retrogression more with the supply of superfluities than of pure necessaries; but at the same time it must be allowed that a Niebuhr is required to distinguish cause and effect in this physical, even more than in the political, history of our species. When then a statesman is asked "Why will you not carry a 'Maine Liquor Law?' Why will you not do all you can to put temptation out of the way of the intemperate?" he gives a sufficient answer when he says "Because liquor is nice (to some palates); and I will not deprive my noblest and most cherished countryman, the temperate man, of a pleasure likely to make *him* stronger and happier."

The last clause brings the question to an issue which it is the business of the physiologist to give judgment on. What is *experimentally* the effect of alcohol on the system?

The experiments of Dr. Böcker* enable us to be as explicit on this point as about water and salt: they appear to have been made as carefully as those already detailed on the effects of water. He lived as usual, and took seven or eight times a day a teaspoonful of spirits of wine. The immediate results may be stated in the five following deductions:

1. Alcohol diminishes the excretion both of the solid and fluid constituents of the *urine*.

The following table exhibits the daily difference between the ordinary excretion and that which took place under the influence of alcohol, taking a mean of nine days of the former and six days of the latter.

Under the use of alcohol there was a daily diminution in the amount excreted:—

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* *Beiträge zur Heilkunde.* Von F. W. Böcker, Praktischem Arzte, Wundarzte, und Geburtshelfer. Zwei Bände. Crefeld, 1849.

		Grammes.			
Of urine to the extent	of	1151·739,	or $\frac{4}{15}$	of the whole	average quantity.*
Of water in it	of	1115·493,	or $\frac{4}{15}$	"	"
Of solid constituents . .	of	36·246,	or $\frac{4}{15}$	"	"
Of urea	of	13·366,	or $\frac{4}{15}$	"	"
Of uric acid	of	0·091,	or $\frac{1}{4}$	"	"
Of mucus	of	0·093,	or $\frac{1}{3}$	"	"
Of fire-proof salts . . .	of	9·351,	or $\frac{1}{4}$	"	"
Of earthy phosphates . .	of	0·278,	or $\frac{1}{6}$	"	"
Of other salts decomposed by heat, with extractive matter† .	of	13·359,	or $\frac{6}{15}$	"	"

2. Alcohol does not increase the *cutaneous perspiration* to any practical extent.

This is not measured, but judged by sensation. Dr. Böcker finding that at night indeed he perspired somewhat more than usual, but by day much less. This shows, at any rate, that the skin does not take the place of the kidneys in exhaling water under the circumstances experimented upon, for had it done so the body would evidently have been bathed in perspiration all the twenty-four hours.

3. Alcohol does not augment the *fæcal excretion.*

4. Alcohol diminishes not only the absolute quantity of *carbonic acid exhaled by the lungs*, but also the relative proportion of it in the products of respiration, though it quickens the frequency of the pulmonary movements.

The experimenter calculates that when using alcohol he excreted daily 165744 cubic centimetres, or about $\frac{1}{7}$th less than his ordinary quantity.‡ After the alcohol was left off, the pulmonary movements continued quicker than natural, while the carbonic acid exhaled returned to its normal standard; so that there were more products of respiration expired than even in the previous condition. This was confirmatory of the arrest of excretion being really due to the reagent employed; it was the *experimentum crucis* required by the logical observer. It is no doubt open to conjecture that there occurred a compensatory increase in the carbonic acid excreted by the skin, but as that is reckoned, probably correctly, by Dr. Hannover to be at most only one twenty-fifth of the excretion of the lungs, it is difficult to imagine it could to any practical extent take their place. As to any compensatory excretion of the gas by the bowels that would have been obvious enough to the senses.

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* The "average quantity" was ascertained by experiment immediately before each series of experiments on different substances, and was different according to the different times of the year. This explanation is necessary in order to account for the different fractional parts of the whole which the quantities are stated to constitute.

† For the materials of the above table compare p. 246 with p. 196 of Böcker's *Beitrage zur Heilkunde*. The approximate fractions are introduced to make the facts more striking.

‡ The diminution of the quantity of carbonic acid excreted in the expired air while taking alcohol has been confirmed by the experiments of Dr. Duchek on dogs.—*Vierteljahrschift fur pract. Heilk.* 10*ter Jahrg.*, bd. iii.

Alcohol therefore is not a supporter of combustion in the body; nay, it is a very decided arrester of the oxidation of carbon.

5. The excretion of *water* by the lungs was unaffected to any important extent, that is to say, it was diminished by an equal to $\frac{1}{133}$ of the whole. This is a further blow to the theory of alcohol supporting combustion.

What now are the deductions from the above-detailed immediate physiological actions? What is the true use of that alcohol which all acknowledge to be instinctively liked?

"Alcohol," says Dr. Moleschott, "is *a box for savings.* A man who eats little and drinks moderately of alcohol retains in his tissues and blood more than he who, under corresponding circumstances, eats more without taking beer, wine, or brandy. Clearly then it is hard to rob the labourer, who in the sweat of of his brow eats but a slender meal, of a means by which his deficient food is made to last him a longer time."[*]

This is going rather too far. When alcohol limits the consumption of tissue by metamorphic secretion, and so the requirements of the system, while at the same time the man goes on working, it is right to inquire whence comes his new strength? It is supplied by something which is not decomposition of tissue—by what then? A truly vital question, but one that should have been answered before the above quoted argument was allowed full sway, for on it depends the knowledge whether a man is only gaining additional strength or wasting his body, spending his income or wasting his capital.

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[*] *Lehre der Nahrungsmittel. Für das Volk.* Von Jac. Moleschott. Erlangen, 1853.

However there is a middle road: a man may so spend his capital as to enable him to replace it with interest afterwards, and be in a more prosperous condition than if he had not speculated. And such appears to be really the state of the case as respects alcohol: by raising the nervous energy it enables a man so to use his body that during the consequent rest he absorbs or fixes enough to place himself in a better state than before. It prevents that exhaustion or wearing out of the absorbing tissues which makes the machine less efficient for growth than before; and it allows without damage a certain amount of extra work bodily or mental, to be imposed by using indeed the substance of the body for a time, but enabling it to be replaced with interest afterwards.

But these advantages are not to be gained without the chance of paying a price for them. Dr. Böcker has taken the opportunity of comparing the blood of persons accustomed to drink brandy daily, but not in excess, with that of a typical abstainer; and he finds it as a whole deficient in solid organic constituents, deficient in fibrine as compared with albumen, and with the red clot more carbonized, or at least more black than in perfect health. At the same time there is an excess of the pale or colourless corpuscles over the number which ordinary blood possesses.* That is to say, in short, that the blood is less vitalized, is a anæmic, and at the same time too venous, too much in the condition of that of the portal system: it retains too much of the effete matter, and is deficient in new active globules. Such is the bad effect of alcohol taken as a daily habit for a long time, and the question is whether each indulgence in its use adds a grain to the heap, or whether we may not get the good out of it and avoid the evil.

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* The pale globules Dr. Böcker holds with Dr. Virchow to be defunct bodies, no longer capable of performing their duty of absorbing oxygen; a view which has received confirmation from some experiments of Dr. Moleschott's published in Müller's *Archiv*, in which he found that frogs, from whom the liver had been excised, lost their power of expiring carbonic acid and absorbing oxygen in the proportion as these cloudy-tinted globules increased in number.

It is possible that this defensive power of alcohol may be the result of purely chemical or other physical agencies; that merely by its reactions on the corporeal substance it may enable the body to make up for the primary loss sustained. But this is only a possibility, and cannot yet be stated as a fact in favour of alcohol.

The really strong point is one grounded not on physical agency at all, and one which, curiously enough, seems to have been quite passed over by Dr. Donders, Dr. Moleschott, Baron Liebig, Dr. Pereira, and all other modern dieticians, viz., the effect of alcohol as a prophylactic against the destructive energies of the mind. It is unnecessary here to quote proverbs in all tongues to show how work purely mental exhausts the body; how, for instance, not only the painful emotions, care, sorrow, anxiety, but also the nobler enthusiasms, the afflatus of the poet, the ambition of the patriot, the fixed attention of the scholar, the abstraction of the lover, fret to dust their tenement of clay. Whether this arises from defective assimilation or increased destruction in the tissues is not known, and does not affect the argument. Animals have not these causes of friction in their machinery, and require no defence against them; but we (thanks to the tree of knowledge) all of us daily experience them more or less, sometimes in a pleasant sometimes in a painful degree, and to soothe our moved minds instinctively or rationally adopt some of the remedies which nature and art afford.

"Then alcohol is an accessory *medicine*, not *food?*" Really it does not seem of any importance which you call it. If the passions instanced above are natural and normal, then it is a "natural and normal medicine;" and between that term and mine of "food" the boundaries are too fine for practical purposes. With those who deny that the higher employments of the soul *are* natural, no arguments will avail.

The reader must believe that it is under a heavy sense of responsibility that any of the advantages of alcohol are brought forward. It is superfluous to say how the use is defiled by the abuse, how the curse rings out so loud that the quiet blessings are scarce heard. A Silenos may well cry in merited repentance,—

"'Ω Βρομίε, διὰ σὲ μυρίους ἔχω πονοὺς,"

but a thoughtful, reverent mind may discover sufficient evidence that the good outweighs the ill, and instead of condemning with superfical haste as an enemy the powerful agent he sees before him, will try and make it more and more friendly to his species, and will endeavour to discover what form of it combines the least harm with the most good. To such a mind the further experiments of Dr. Böcker on different forms of fermented drinks will possess much interest.

The effects of **Beer** are well exhibited in some further experiments made by the same hand.[*] He took during the observation of the urine, his ordinary diet, except that he added to it at breakfast half a maass (about an imperial pint) of sound home-brewed beer, containing 47·2 parts per 1000 alcohol. When observing the variations of the pulse, and excretion of carbonic acid, he drank various recorded quantities, from one to as much as five maass.[†] The result of these experiments is, that there is a general resemblance between them and those with pure spirit, modified apparently in close proportion to the smaller quantity of alcohol contained in the drink under discussion, and to the amount of the antagonistic agent—water—therein absorbed. The only well-established particular which is not explicable on these grounds, is the much greater quantity of chloride of sodium excreted in the urine under the use of beer than of alcohol; a difference, for the cause of which we must look to the other substances contained in the compound—viz., to the extracts of hops and of malt, the sugar, æthers, &c., or to their combined action. According to the analyses of Herr von der Marck (a friend of Dr. Böcker's), beer contains itself scarce a trace of chloride of sodium, and very little chloride of potassium; yet on the beer days, the experimenter found three grammes more of the former salt were in his urine than on the other days. So that there is no doubt about a physiological action of this drink independent of the alcohol and water it contains—viz., an action tending to the elimination of tissues containing chlorine.

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[*] *Ueber die Wirkung des Biers.* Von Dr. Böcker. ('*Archiv des Vereins für gemeinschaftlichen Arbeiten zur Förderung der wissenschaftlichen Heilkunde.*' 1854.)

[†] In estimating the accuracy of Dr. Böckers of observation, it is necessary to remember that the beer was mild. London porter contains from 65 to 80 parts, and "Bass" as much as even 128 parts in a 1000 of alcohol, that is, nearly three times as strong as the German. The maass varies in different parts of Germany from 2 to 3½ pints; it is probably the smaller measure that is used at Radevormswald, where these experiments were made.

The experimenter has not confined his attention to the excretions; the variation in which from beer, being so analogous to those induced by alcohol in a dilute degree, need not be here repeated. But he has also noted the immediate changes wrought in the circulating blood. Three persons in good health were bled, and the blood analysed, first, after a fortnight's course of teetolalism, and secondly, after a diet of eight, fourteen, and fourteen days' duration respectively, taking from two to three maass of beer daily. The result was a decrease of water, an increase of fibrine, an increase of coloured clot. The clot, however, reddened with exposure to air much less rapidly than in quite normal blood, and contained many more of the pale, unnucleated globules than is usual in the condition of perfect health.

The inference which we may draw from these last experiments is, that the immediate effect of the fermented drink in question is not to diminish the instruments of life, but to retain (temporarily at least) a certain quantity of matter usually excreted. Though not very conclusive, they show at least that the consequence of alcoholic drinks is not necessarily the decrease of the solids in the circulation; thus correcting in some degree the previously quoted analyses of blood from brandy drinkers, and showing that they exhibit effects different by reason either of the cause being a chronic one, or of the agents not having exactly the same action.

As in the case of beer, so too of WINE, experiment shows a considerable resemblance in the effects to those of pure alcohol modified by dilution; while, at the same time, there are certain differences from both liquids, important in a practical and scientific point of view.* The wines employed by Dr. Böcker were Niersteiner, a good second-class white Rhenish wine, and Walportzheimer, a red wine, made indeed in the Ahr country, but from the Burgundy grape.† From one and a half to two and a half bottles were drunk daily, without otherwise altering the diet. The results were in both cases a scarcely perceptible alteration in the bulk of the cutaneous, urinary, and fæcal excretions indeed, but a diminution, devoid of doubt, in the quantity of carbonic acid expired, and that this latter phenomenon was more marked in the red Waltportzheimer than in the white Niersteiner.

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* Dr. Böcker's *Beiträge zur Heilkunde*, band i.

† Dr. Böcker proposes, at a future opportunity, to test effervescing and foreign wines—experiments which will possess more interest for our countrymen than those made on the insufficiently appreciated German grape.

That which however seemed peculiar to vinous liquors, and which probably is the physical effect of most practical import, was a striking diminution in the quantity of earthy phosphates in the urine. When we consider the important tissues from whence these phosphates principally come, no less than the bones and the brain, and what an overpowering influence their renewal or destruction must have, too great value cannot be attached to an agent which possesses the property of modifying them. It must indeed be a two-edged sword in the hands of the employer, capable of doing infinite good and harm.

It is very evident from these experiments that to know the powers of fermented liquids it is not sufficient to know merely the action of alcohol, and the quantity of that principle which they contain. Alcoholized stimulants are not merely alcohol diluted. Their effects on the nervous system and mind do not bear even a direct ratio to their contents. Many other ingredients certainly contribute much to their gladdening of the heart, and probably also to their benefit to the body. Sugars, acids, essential oils in great variety, fruity æthers constituting the flavours or "bouquets" of wines, tar, turpentine, &c., are the differences between the produce of one vineyard and another. A certain quantity of alcohol seems essential to their wholesomeness and popularity: but experience shows that many of those compounds which contain a minimum amount of it, perform their exhilirating duties as well as more potent potations.

In using the fermented liquors above alluded to, the temperate man is less likely to exceed by error, and the indiscreet is under less temptation. They have the same advantage as finely graduated scales over coarse ones—*they are a better measure of the quantity wanted*, and the use of them therefore should be encouraged by all social and political expedients.

As a rough rule it may be said that those fermented drinks are most worthy of approbation which produce the greatest amount of exhilarating effect with the least amount of alcohol, reserving however the possibility that there is a certain minimum beneath which the alcohol should not descend.

Beer perhaps fulfils the above-named desiderata better than any of the national drinks of Northern Europe; a small quantity of alcohol is mixed with a still smaller proportion of a narcotic, the whole diluted with water, sugar, and flavouring substances, the products of the semi-combustion of the malt. There is also in English beer a considerable quantity of vegetable albumen which may take the place of a complementary food.

For those to whom expense is no object, light wines are doubtless more desirable. The perfection, as a drink, of the Bourdeaux vintage is so great that an extension of the growth would be a worthy object to be attained by an European or a world alliance. The joint recreation of the senses of taste and smell by the finer sorts takes away the temptation to exceed in mere drinking, and a very small quantity, containing in fact only a few drops of absolute alcohol, is sufficient to produce the beneficial effects of wine. Surely the restoration of those vintages to our middle classes, instead of the *soi-disant* Spanish and Portuguese manufactures now so usually drunk, could not fail to improve their bodies and minds, and is worth a temporary sacrifice of the income derived from the duty.

Our farmers need not fear for their malt; for such wine would not be a substitute for beer, but for brandy and water, toddy, and such like mere dilutions of alcohol, the boozing over which destroys so many of our tradesmen and clerks.

As an economical experiment it has often appeared to the author worth while to try whether the great quantity of *sugar of milk* remaining over from the manufacture of cheese might not afford a valuable fermented drink. Baron Liebig in his *Familiar Letters*, says that "in the dairies of England thousands of hundred-weights of this valuable respiratory matter are annually lost." This is not strictly true; they are *not* lost for human food, they are made into pigs, and so into bacon. But still the glowing descriptions given by travellers in Tartary, Circassia, and all Northern Asia, of the direct use of the valuable products of the fermentation of this sugar, makes one regret that a trial at least is not made to preserve it.

Mr. Spencer says that the Circassians never take milk raw, attributing to it fevers and other diseases; but first boil it, and then add as a yeast some fermenting milk reserved from the previous brewing, producing thus a light sharp exhilarating drink, which is the staple liquor of the country under the name of "skoa." Either sweetened, flavoured with rose water, or plain, the author says it is one of the most grateful and refreshing beverages he has ever tasted. The natives consider its manufacture in the light of what the Americans call an "institution," and say that it was taught to Hagar by the angel.* Curiously enough the art seems to have declined in refinement instead of advancing, perhaps in consequence of the spread of Mohammedanism. Modern authors speak only of one sort of fermented milk, whereas old William of Rubruk, who went to Tartary on a mission from St. Louis in 1253, found the heathen natives much more civilised in this respect as in several others. He speaks of a white variety and a black, as we have our white and red wine; he says too, that there was one sort thick and heavy, which the servants used, and which made them sleep; another thin and clear for the masters, which he describes as "for certain a wondrous sweet and wholesome liquor."† The worthy Franciscan seems to have been as much pleased with the flavour as our modern traveller. "After a man has taken a draught, it leaves a taste behind it like that of almond milk, going down very pleasantly and intoxicating weak brains." Then as now, it seems to have been a sort of institution, for in warm weather a jar stood by the door, with a minstrel near it, and whenever the master of the house drank "the servants cried 'Ha!' and the minstrel played upon the fiddle." And "in summer, as long as their cosmos (the name given this liquor) lasts, they care nothing for other food." In winter they drank a sort of mead of fermented millet and honey, which William of Rubruk does not praise, and Mr. Longworth pronounces nauseous as now brewed.[*] This last then we will not envy, but the first named sounds as if it would really be a boon.

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* *Letters on Circassia.* Letter xxxii.

† "Et est pro certo valde suavis potus et bonæ efficaciæ. *Itinerarium fratris Willielmi de Rubruquis, de ordine fratrum minorum, Galli, anno gratiæ* 1253. This most interesting account of Northern Asia is printed in Hakluyt's *Collection*, vol. i. There is also an English translation in *Purchas his Pilgrimes*, vol. iii.; and a French one in *Recueil de Voyages et de Mémoires Publié par le Société de Géographie*, which I have not seen. It would well bear republication now, when we are fraternizing with a people of similar habits on the shores of the Black Sea, and when we seem to have a good chance of coming in contact with their remote relations in China. The curious account the Franciscan missionary gives of the liberal monotheism of the Tartar tribes, and of their willingness to receive Christianity as a history but not as a faith, may perhaps explain some of the paradoxes of the Chinese rebellion, and lead to our finding things not so new as they look.

It is an interesting point for investigation, and one too not without practical utility, to inquire whether the immediate results of alcohol are continued after that agent has left the body, or whether it is really retained all the time that the phenomena produced thereby are manifested. The most recent and important experiments bearing on this matter are those of Dr. R. Masing, who has published in an inaugural treatise the result of some analyses of various parts of the bodies of dogs at various periods, after being dosed, not in fatal quantities, with alcohol.[†] The longest period at which a dog was killed after taking the spirit was thirteen hours after the last dose, when all unsteadiness of gait and other marks of intoxication had vanished. In both blood and body evidences of the presence of alcohol were found, faint indeed, but quite satisfactory to Dr. Masing and his collaborators. In a dog killed six hours and in another killed three hours after the last dose, while the heavy sleep of drunkenness remained, the reactions taken in evidence were much stronger, and indeed seemed proportioned to the time since the last ingestion of spirit. From thence it would appear that the effects of alcohol are really traceable to the permanence of the drug in the system, and that they get weaker as it is excreted, and finally go off before the cause has finally left the body—in fact that the effects are closely proportioned to the quantity of the agent actually in the system.

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[*] Longworth's *Year among the Circassians*, Vol. I., Chap. III.

[†] *De mutationibus spiritûs vini in corpus ingesti.* Scripsit Rudolphus Masing. Dorpati, 1854. The object of the treatise is to show cause for believing that alcohol is absorbed unchanged, and remains in blood and flesh unchanged during its action on the system, in opposition to the opinion of Dr. Duchek, who believes it to be all converted into aldehyd. The gist of the argument lies in the validity of the chemical tests for alcohol and aldehyd, but that does not affect the applications of the experiments to the present purpose.

The mention made of the peculiar limitation of the loss of earthy phosphates by wine, leads us to the mention of another accessory food of wide-spread use—SUGAR. The result of observations made on the excretions during the use of it by Dr. Böcker,* shows that it, as well as those articles already named, restricts the waste of the body by decomposition, and that its effects are most marked on these products of the destruction of bone, and that in a much greater degree than anything as yet noticed; so as to lead to the question, Whether some of the differences between the action of alcohol and fermented liquors may not be partially due to the presence of this substance? But besides that, its use is so universal in civilized nations, that a knowledge of its pure physiological effects cannot but be interesting.

Dr. Böcker made, as in the former experiments, no change in his usual mode of life, but took in addition about two ounces (four "*loth*") of pure sugar daily for nine days.

1. The result *to the urine* of the nine days on which this was done, as compared with fourteen days in which he lived as usual without the sugar, is shown in the following table:—

On the sugar days each twenty-four hours there was a diminution in the amount excreted—

	Grammes.			
of urine to the extent .	of 67·398, or $\frac{1}{30}$	of the whole average quantity previously observed †		
of water in it	of 53·343, or $\frac{1}{48}$		"	"
of solid constituents . .	of 14·055, or $\frac{1}{5}$		"	"
of urea	of 8·565, or $\frac{1}{3}$		"	"
of uric acid	of 0·104, or $\frac{1}{3}$		"	"
of fire-proof salts . . .	of 4·881, or $\frac{1}{5}$		"	"
of soluble salts	of 4·150, or $\frac{1}{5}$		"	"
of insoluble salts	of 0·731, or $\frac{1}{4}$		"	"
of earthy phosphates . .	of 1 039, or more than $\frac{1}{3}$, viz. ($\frac{19}{36}$)			"
of phosphate of lime . .	of 0 860, or more than $\frac{1}{2}$, viz. ($\frac{15}{26}$)			"

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* *Beiträge zur Heilkunde*, b. i., p. 33.

† See note to page 190.

	Grammes.	
of phosphate of magnesia	of 0·179, or $\frac{3}{8}$	of the whole average quantity previously observed.
of salts decomposed by heat and extractives	of 0·507, or $\frac{1}{37}$	" "

of sulphates there was no diminution.[*]

3. The *cutaneous perspiration* was not sensibly affected, and the fæcal secretion was for a few days diminished, and then returned to its natural standard.

3. Led by the nomenclature of Baron Liebig, in which sugar is called a respiratory material or food, we might have been led to expect that it would augment the amount of *carbon expired.* Such however is not the case; a mean of fifty experiments on the quantity of carbonic acid secreted in the lungs during the sugar days, compared with seventy experiments under ordinary habits, shows a very decided deficiency in the former, both in air expired and in carbonic acid contained in that air. The daily deficiency of carbonic acid amounted to 44308 cubic centimetres, that is $\frac{5}{38}$ths of the whole quantity of this excretion. Small is this arrest of the decomposition of carbon, compared with that which was found to belong to alcohol, but yet it is sufficiently marked not to be accidental, and to stamp a character upon the physiological actions of the substance.

Like, however, as its action on the carbonic excretions is to that of alcohol, it exhibits one remarkable difference which must not be passed over. When speaking of alcohol it was stated that immediately its effects passed off there was a sort of elastic reaction of the system, which caused it not only to return to its ordinary habits, but to give out more than natural for a certain period. In the case of sugar the contrary happened, and its effects not only continued, but *increased* for a short time after its disuse. This is an observation of some importance, as showing that with alcohol we may expect a reaction, which does not follow the use of sugar.

4. The secretion of *water by the lungs* was reduced to the extent of 24 grammes or $\frac{1}{18}$th of the whole daily average.

It is to be remarked that at the same time as he took sugar,

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[*] Compare pp. 48 and 67 of *Böcker's Beiträge* for the materials of the above table. The mode of arrangement in the original does not set the facts very clearly forward.

Dr. Böcker increased the amount of water drank above that which was required by the instinct of thirst, in order to wash down the substance without allowing it to remain long in the mouth. His reason for doing this was, that when taken dry it gave him a severe tooth-ache, so as to destroy his night's rest, and if that had been allowed to go on the value of the experiments would have been lessened. When it was taken as syrup, no pain in the teeth followed. Now we have seen before, that water in accessory quantities is a great promoter of metamorphosis, and that under its use all the secretions were augmented; so that it may be safely asserted that, had it been abstained from the arrest of secretions, especially that of the aqueous portions of them, would have been much more marked.

In spite of this counteracting influence, it is very obvious that a diminution of all the products of moulted tissues occurs under the use of sugar, but that the proportion in which they are diminished is very different from what was observed in the case of alcohol.

In that case it was the *urea*, and the *extractive* or coloring matters, in which of all the solid constituents of the urine the greatest diminution was found, the former being less by $\frac{4}{10}$ths, the latter by $\frac{6}{10}$ths, when alcohol was taken; whereas by sugar the former is diminished to the extent of $\frac{1}{3}$rd, and the latter scarce at all.*

Here it is the earthy *constituents of bone* whose removal is arrested. The earthy phosphates are lessened by more than $\frac{1}{3}$ when sugar is taken, whereas under the use of alcohol the difference was only $\frac{1}{6}$th from the average secretion.

In this remarkable peculiarity in the physiological action of sugar is to be found the reason why it is so largely supplied to the young animal in the mother's milk. The constant motion of the growing limbs demand a rapidity of life in the muscles, and promote a continuous moulting which would be fatal to the stability of bones; so they are defended against the over-weening waste by the great quantity of sugar which the mammary secretion always contains. A beautiful provision this is in Nature, but it is still more striking when we find that the supply of sugar to different sorts of animals is in very close proportion as their bones are required to be strong and firm. The lumbering ox, who in his youth staggers about with proverbial ungainliness, and who in really civilized countries is left to only his proper business of getting fat, has the smallest supply of sugar of any commonly known animal.

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* It is to be remarked that the quantity of meat eaten during the time of taking sugar was not diminished, in spite of the appetite being sometimes a little cloyed by the sweets; so that no weight can be attached to the explanation of Dr. Guleke, who suggests that the diminution of bone earth in the urine was due to the lessened quantity of that salt ingested in the victuals.—*De vi Magnesiæ ustæ alvum purgante*, auctore A. Guleke, p. 16. Dorpati, 1854.

Man has from four to six per cent. of sugar in the solid constituents of the milk he gets, while the *colt* has nearly nine per cent. to harden his compact skeleton. The *ass* has between six and seven per cent: the *kid* and the *lamb* rather less. While *puppies*, again, are worse off in this respect than even calves; a fact which explains the wise cautions our sporting friends give us against working them too early, lest we should spoil the form of their legs.*

These considerations should teach us to be careful not to omit the sugar when we substitute cow's milk for human in feeding our own children, and not to oppose too much the instinctive taste of our young friends for sweets.

In saying a few words in favour of alcohol, a much more difficult position has to be occupied than is requisite for any other of the accessory aliments. It sins in public and does its good deeds behind a bush, so that there can be no wonder at its ill fame among those whose eyes are not formed for deep penetration.

The other "extra drinks," TEA, COFFEE, and CHOCOLATE, have a much less suspected character; it is only as medical men, not as moralists, that we can ever be called upon to say anything at all against them; and in addition to their real uses they often get imaginary ones assigned to them, like eminently respectable persons of our own species. No accusation having been made of social or individual injury of calculable extent resulting, and a very decided gratification occurring, there can be no doubt of their use being a gain to the nation. They are a pleasure without consequent pain.

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* The analysis of the milk of the various animals is collected by Dr. Lehmann (*Physiol. Chemie*, vol. iii., p. 388) from several sources, but he does not make any remark on the final causes of the difference.

But shall we attribute no further value to these articles? shall we say that money to the amount of twenty-six millions sterling, annually spent by our country in their purchase, is laid out on a temporary titillation of the nerves, and that just as much has to be expended on other food as if this luxury had not been imported?

Such questions are answered by an equally elaborate and self-sacrificing collection of experiments made upon himself by Dr. Böcker,* for the purpose of testing the effects of TEA on the organism. The first set of the first series consists of seven observations of twenty-four hours' duration each, in the months of July and August, with three barely sufficient meals *per diem*, in quantities as nearly equal each day as could be managed, and only spring water to drink. The second set comprises the same number of observations in August, September and October, under similar circumstances, except that infusion of tea drank cold was taken instead of plain water. Each day there are carefully recorded the quantity of urine, of eighteen of its ingredients separately, the weight of fæces and of the water and solid matter contained therein, with the degree of alkaline re-action, colour and odour, the amount of insensible perspiration, and of expired carbonic acid, the quickness of respiration, the beats of the pulse, together with accurate notes of the duration of bodily exercise in the open air, the loss of weight in the whole body, the general feelings, and the circumstances, thermometric, barometric and meteoric, under which the observations are taken.

It was desirable for the accurate comparison of the results that a nearly equal quantity (and that necessarily a *limited* quantity) of food should be eaten daily; and in consequence there was a certain loss of weight entailed. This might seem to some persons to vitiate the conclusions, inasmuch as the body was not quite in a normal state; so a second series of seventeen experiments of equal duration were made, and at a different time of year, so as to answer the question which might arise as to whether the season made any difference. In these the weight of urinary constituents and of the fæces were examined under the three following circumstances, viz., while taking tea as an ordinary drink, on the days immediately following the leaving it off, and the other days when it was not taken. Solid food was eaten in measure limited only by appetite.

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* *Archiv des Vereins für gemeinschaftlichen Arbeiten zur Forderung der wissenschaftlichen Heilkunde.* 1853.

A third series of four experiments was also made during four fasts of thirty-six hours each, two with water only, and two with tea to drink On these occasions the author's business did not allow him to place himself under precisely equal conditions of occupation, and moreover, his weight at the commencement of each observation was not the same. So that in some phenomena, especially as respects loss of substance, they do not agree with the two former series.

However, in the following particulars all the three series so entirely coincide, that the conclusions will be set down as general deductions from the whole. The details of each will be quoted only as illustrations or as indications of modifying circumstances.

1. *Tea in ordinary doses has not any effect on the amount of carbonic acid expired, the frequency of the respirations or of the pulse.*

2. *When the diet is insufficient, tea limits very much the loss of weight thereby entailed.*

This is strikingly shown in the first series of experiments. In the seven days on which tea was taken to drink, the weight of solid matter eaten was on an averge 12·39 grammes (7 drachms avoird.) less than when water alone was drunk: yet the loss of weight of the whole body was on each of the former days but 203 grammes, on the latter 539 grammes, showing a wear of 336 grammes (nearly 12oz. avoird.) less under the influence of tea than with water only.

3. *When the diet is sufficient, the body is more likely to gain weight when tea is taken than when not.*

This is shown in the second series of experiments; the tea drinking days of which are the only instances of augmented weight.

Tea diminishes very much the loss of substance in the shape of

In the first series the daily allowance, though less copious on the tea days, was more nitrogenised, and nitrogen also it must be remembered was taken in as theine, yet in spite of this the quantity of urea secreted in twenty-four hours was nearly a gramme less than on the water days, the numbers being in the first case 34·22, in the latter 35·19 grammes. The quantity of water and other constituents passed in the urine was also lessened.

Still more strikingly is this shown in the days of complete fast, when pure spring water is seen to cause a greater loss by urea than infusion of tea, in spite of the supply of nitrogen contained in the latter. The difference also is seen to exist in spite of an increased amount of bodily exercise.

5. *Tea lessens remarkably the quantity of fæces secreted.*

In the first series of experiments with insufficient diet on the tea days, their weight was on an averge 96 grammes, on the water days 178 grammes. In the second series it is remarkable that on the days immediately following leaving off tea and taking to water, a great augmentation of the fæces is noted, as if water alone acted as an evacuant in those who are habituated to tea.

6. *The loss by perspiration is also limited by tea.*

In the first series it was 1335·7 grammes on tea days, on water days 1349·9 grammes.

Parallel with these observations there run a set of experiments made by Dr. Julius Lehmann, on two individuals, to exhibit the effects of COFFEE or the excretion of phosphoric acid, chloride of sodium and urea, by the kidneys.* They are less full than Dr. Böcker's in that they concern the urine alone, and are less in number, but on the other hand they are more complete in showing the separate actions of the several constituents of the coffee bean—viz., caffeine and empyreumatic oil, as well as of the mixture. Some of the effects of excess are also shown, to which the paper on tea makes no reference. The results are as follows:—

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* Ueber den Kaffee als Getränk in chemisch-physiologischer Hinsicht. *Annalen der Chemie und Pharmacie*, vol. lxxvii., p. 205.

1. That coffee produces on the organism two chief effects which is very difficult to connect together—viz., the raising the activity of the vascular and nervous systems, and protracting remarkably the decomposition of the tissues.

2. That it is the reciprocal modifications of the specific actions of the empyreumatic oil and caffeine contained in the bean which call forth the stimulant effects of coffee, and therefore those peculiarities of it which possess importance in our eyes—viz. the rousing into new life the soul prostrated by exertion, and especially the giving it greater elasticity, and attuning it to meditation, and producing a general feeling of comfort and cheerfulness.

3. That the protraction of metamorphic decomposition which this beverage produces in the body is chiefly caused by the empyreumatic oil, and that caffeine only causes it when it is taken in larger quantity than usual.

4. That caffeine (in excess) produces increased action of the heart, rigors, derangement of the urinary organs, head-ache, a peculiar inebriation, delirium, and so on.

5. That the empyreumatic oil (in excess) causes perspirations and diuresis, quickened motion of the bowels, and augmented activity of understanding, which may indeed by an increase of dose end in irreglar trains of thought and congestions, restlessness and incapacity for sleep.

Though both our authors have frequent occasion to allude to the effects of tea and coffee on the mind, produced as they have just reason for concluding through the body, yet they do not seem to have thought of taking into consideration the reciprocal consequence—the reaction of the spiritual on the material. But we cannot doubt that while mental comfort results from the physiological action of these ailments, this mental comfort also helps towards the healthy working of the organism. The subject is too familiar to need much illustration, and has been lately brought under the reader's memory.

Perhaps too they have not allowed sufficiently for the effect of habit on the subjects of their experiments; that is to say, of habit acting through the mind. If a man has been used to take tea or coffee daily for many years, it is a constant slight source of annoyance to give it up, and this may cause him to exhibit rather more loss of substance under water-drinking than arises from the mere physical action of the change. If an individual has always walked with a slouch, or with his hands in his pockets, or touched the posts as he went through the streets, he would, if debarred from these customs, most likely pass an increased amount of urine and fæces. Recruits always lose weight, though their work may be less laborious than previously. And it is difficult to say how long this mental influence would last. Dr. J. Lehmann permits indeed a few days to pass over before he commences his estimate—in fact, he waits till the amount has got steady; but it may be doubted if that is quite sufficient. Dr. Böcker has not allowed for this disturbing influence at all. However, though these latter considerations may make us think the figures in the results perhaps a little exaggerated, they by no means invalidate the conclusions.

The distinct statements of Dr. Lehmann, and the daily records by Dr. Böcker of his feelings and sleep, of the colour, smell and consistence of urine and fæces, show that the subjects of these experiments were in a practically normal state during the whole of the time they were under observation, so that any fallacy supposed to arise from pathological causes for the variations in the bodily phenomena is excluded. We may take them to represent the real effect of tea and coffee on a healthy person.

What an important effect this is! The tea and coffee drinker may have less to eat, and yet lose less weight—wear his body out less—than a water drinker. At a comparatively small expense he may save some of the costly parts of his diet, those nitrogenised solids that entail so much thought, labour, and anxiety to obtain. The loss of carbon indeed goes on much as usual, and a moderate outlay will supply that; but what an economy it is to spare the quantity consumed of meat, bread, milk, and all the most expensive viands!

Besides the theine (or caffeine, for they may be viewed, for the present purpose at any rate, as identical) and the essential oils, there is contained in both tea and coffee a certain amount of difficultly soluble vegetable albumen, and in the former especially a large quantity of tannin. The presence of these substances introduces several modifications in the modes of using the plants as a beverage, and renders one or the other best fitted for people under different circumstances. The tea leaf, infused for a short time, parts with its essential oil and a small portion of alkaloid, a good deal of which, with the tannin and vegetable albumen, is thrown away with the grounds. If it stands too long or is boiled, more indeed is got out of it, but an astringent disagreeable drink is the result. Hence it is more suitable for those who can afford to waste some of their food, for the sake of having the rest more agreeable. The boiling of coffee extracts all its oil and alkaloid too, and, when it is drunk in the Eastern method with the grounds, allows the whole nutriment to be available. Even when strained it is clearly more economical than tea, and appears therefore the most proper beverage for a poor man. It may be doubted, however, whether we might not make our tea go further than is at present the custom, if we were to adopt other modes of preparation. The following description of the cookery adopted among the Buratsky Tartars is from the travels of Bell of Auchterony, written in the middle of the last century, but it is to be observed that MM. Huc and Gabet give a similar account of that employed in the wilds of Chinese Tartary in the present day.

"A large iron kettle was placed on the fire and wiped clean with a horse's tail, then water was put in, and then coarse bohea tea and salt. When it was near boiling, she took a large brass ladle and tossed the tea till the liquor turned very brown. It was now taken off the fire, and after subsiding a little was poured clear into another place. The mistress now prepared a paste of meal and fresh butter, that hung in a skin by the horse's tail, which was put in the kettle and fried. Upon this paste the tea was poured, to which was added some good thick cream. The ladle was again employed for about six minutes, when the tea being removed from the fire was allowed to get cool."*

In this there appear three points worthy of at least modified imitation under some circumstances. The mixing of the salt with the tea makes the albumen more soluble, and enables it to be digested, and really with use becomes just as palatable as sugar. Then the consumption of the whole decoction allows of no waste. Thirdly, the addition of meal forms a mixture of complementary and accessory food which must be exceedingly nutritious, while at the same time it probably diminishes the objectionable taste of the tannin. The whole dinner reminds one of the Australian diet of "tea and damper," and, where "damper" is deficient, perhaps may afford a traveller a hint.

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* "Bell's Travels," in Pinkerton's Quarto Collection, vol. vii., p. 852.

CHOCOLATE exhibits, according to its mode of manufacture, a variable amount of the alkaloid allied to that in tea and coffee—viz., theobromine. It is however under all circumstances much inferior to them in respect of this constituent; while the fat, the butter, the starch, and the albumen which it contains may be obtained cheaper and more digestible in another shape. It is a luxury for the rich or an expedient for the invalid, not an economical nutriment. This is sensibly enough felt by our nation, as shown by the Custom House returns. In the year ending January 1st, 1854, while upwards of fifty-eight million pounds of tea, and upwards of thirty-eight million pounds of coffee paid duty for home consumption, of cocoa not half a million pounds were imported for the same purpose. This too is in spite of the much larger quantity of cocoa bean required to make enough for a meal than the other two.

It is to be feared that the list of accessory articles of diet of whose intimate relation to nutrition we have any practical knowledge, is now exhausted. There are many others concerning which, as physicians, we would gladly be able to give a rational opinion, but unfortunately we have been able to investigate only the worst side, and learn the mischief which they do,—

> "Their evil manners live in brass; their virtues
> We write in water."

Yet is it reasonable to suppose that unless they do harm, pepper, spices, ætherial flavours, &c., are simply indifferent? Is all the tobacco burnt in England at the expense of six million sterling a-year pure waste? Surely the universal propensity of our race to these articles should lead us to conclude that there is a use as well as an abuse. To find dyspepsia arising from over much spice, or the salivary secretion vitiated and the nerves shaken by excessive smoking, is easy enough, but we wait for a series of experiments on them like those above related on tea and coffee, to know what happens to those who take them and do *not* suffer.

It would be also very desirable to know more of proposed substitutes for customary beverages. Chicory may be justly set down, even on present information, as no substitute at all, but a cheat and adulteration. It has none of the beneficial effects of coffee. But a considerable interest attaches to the recent introduction from Sumatra of the roasted leaf of the coffee plant instead of the bean.* The author must confess that he finds it nasty, resembling tea made in a coffee-pot, and wanting in "bouquet," but that may arise from its over drying. The great reason for encouraging its importation is the low price, said to be capable of being reduced to twopence a pound, and that it can be grown in a climate where the bean will not ripen. This would indeed be a boon to the labouring man, *if the article is worth having at all*, which in fact is the gist of the whole question, and can be decided only by experience finally, though in defect of that, chemical analysis is not devoid of value.

Now it appears from the analyses of Dr. Stenhouse that the Sumatra coffee leaves are very rich in the desirable alkaloid, and that the same substance is also contained largely in the leaves of the *Ilex paraguayensis*, or Paraguay tea. They contain, in fact, more than the coffee berry, though not so much as the Chinese leaf. The proportions are as follows:—

Good black	tea contains	of theine from	2 to 2·13	per cent.
Coffee leaves	"	"	1·15 to 1·25	"
Paraguay tea	"	"	1·1 to 1·23	"
Coffee berry	"	"	a mean of 1	"

These Sumatra leaves contain also more soluble substance than the beans, in the ratio of 38·8 to 29·1 per cent. The taste and the quantity of essential oil depend probably on the mode of preparation, which evidently requires improvement. At all events we have here offered a chance of cheapening a most valuable article of diet without any cheating or adulteration, and probably a great boon to society.

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* First brought into notice by Dr. Van der Corput of Brussels. Wittstein's *Vierteljahrschrift für pract. Pharmacie*, i., p. 345.

Speaking of cheap teas for the poor leads us to expensive teas for the rich. What is the reason that we so obstinately adhere to our coarse black leaf, when we can well afford the delicious "padre-souchong," scented with gardenia, or the "hyson-pekoe" made from the young buds, or the yellow teas drunk by wealthy mandarins? These would do away with the necessity for milk and sugar, and so avoid one of the most fertile sources of complaint to the dyspeptic.

But alas! by benefiting the poor in the introduction of cheap teas we have mulcted ourselves. In doing away with the monopoly of the India House we have done away with their skilled purchasers, and have no defence against the roguery of Chinese dealers, who adulterate the higher class of teas in such a way that they prove scarce worth drinking, and are a decidedly worse article than the "Strong Black" so ostentatiously vaunted at the grocers' shops. The adulterations of tea enumerated in the *Quarterly Review* of April, 1855, and practised solely on the higher priced sorts, are sufficient to prevent us from attempting at present to enjoy this luxury.

SECTION II. B.—*Accessory Foods capable of Absorption only after previous Change by the Digestive Juices.*

The entire quantity of albuminous and starchy food usually taken above that which is required by the absolute wants of the organism to stave off destruction or loss of weight, may be looked upon as accessory food.

There is every reason to conclude that it is really absorbed and distributed to the tissues; for however much a healthy person eats, it is rare to find any large amount of unaltered starch or albumen in the fæces. Rough clinical observation is sufficient to render it probable that by this excess the quantity of fæces is increased, and the urea augmented in the urine; but whether these augmentations are above the excess of nitrogen taken in as food, or whether they are below that excess, has not been made the subject of exact experiment.

It is on such experiments alone that depends the possibility of assigning them to the class of " arresters " or " hasteners " of metamorphosis. It is evident that if they increase the excretions more than the amount of aliment they bring in, they must be viewed in the former light; whereas, even if the urea, carbonic acid, &c., are got rid of in greater quantity under their use than previously, yet if this greater quantity is under or only equal to the amount ingested, their physiological action must be reckoned as an arrest of metamorphosis.

In the absence of such experiments, the wisest course is a statement of ignorance on the subject.

SECTION III. A.—*Substances submitted to but incapable of Absorption in the Alimentary Canal, being insoluble in water, and inconvertible.*

CELLULOSE.—All the tissue which gives form to plants, consisting as it does of this substance, is to be found unchanged in the excrements of most mammalia, and seems quite incapable of solution in the abdominal juices. To this rule the beaver apparently presents an exception, as Dr. Lehmann says that he and Dr. E. H. Weber have found its stomach wholly filled with wood and bark; and as the animal appears to be nourished entirely on this fodder, we infer that it must possess a power of digesting the same. Now in the beaver the chief difference of its viscera from other animals lies in the great size of its salivary glands. Dr. Weber found them equal to $\frac{1}{118}$ of the total weight of the body, whereas they are in the human species but $\frac{1}{161}$ of the weight. The pancreas too, is large in these animals.* Hence it has been argued that the saliva in its highest state of development possesses the capacity of converting cellulose into starch, and so into dextrin and sugar, in the same way as sulphuric acid does. Dr. Lehmann, however, says he cannot find in the beaver's stomach any proof by means of iodine of a conversion of cellulose.

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* Quoted in Lehmann's *Physiol. Chemie*, vol. iii, p. 283.

It is doubtful therefore if cellulose be soluble at all; and certainly in all cases with which we have any practical concern it is absolutely incapable of such alteration.

The importance, then, of breaking up by preparation and chewing all those forms in which cellulose imprisons nutritious matter is obvious enough. However well it may answer in the barbarous state to swallow meat raw or in lumps, trusting to the stomach to perform the duties of cook and dissolver as well, the same method will not do for vegetables. Nature shows us this in providing all graminivorous animals with powerful grinding teeth, and forcing some kinds to reprepare what has already been partially swallowed and soaked, by making them chew the cud before the morsel is finally submitted to digestion. There are many vegetables most unfairly treated by our species in this respect; radishes for instance, some fruits, salads, &c., are swallowed uncooked and half masticated, and remain solid lumps in the stomach, as our sensations usually inform us, acquiring most unjustly a bad character for wholesomeness. A different mode of preparation might probably be devised which would break up the cellulose without injuring the flavour.

These latter clauses connect themselves obviously with remarks made with reference to mastication, in the section on Albuminous Food,* and are an additional reason for being careful in the preparation of vegetable food previous to its admission into the stomach.

Other substances, such as charcoal, hairs, leather, &c., insoluble in water, or in the digestive juices, are sometimes presented to the alimentary canal, but so accidentally as to demand no separate notice. They are easily recognised in the fæces by those who are acquainted with their microscopic appearances.

SECTION III. B.—*Substances probably incapable of Absorption in the Alimentary Canal, though soluble in water.*

GUM.—Dr. Lehmann so well condenses all that is known about this substance, that I shall avail myself of his words by freely translating them :—

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* Page 176.

"A hydrocarbon, whose use in the animal organism is exceedingly doubtful in spite of its solubility, is *gum*. This substance very rarely occurs in the ordinary food even of graminivora; its reception within the scope of digestion, and its use in interstitial metamorphosis is of little importance, so that we might be almost tempted to overlook it. But we must not do so when we reflect on its frequent use as a therapeutical agent in what may be called dietetic medicine, and the demand on our attention made by the chemistry and physiology of its action.

"In the darkness which prevails concerning the digestion of gum, there are three conceivable possibilities:

"1. That it is changed into sugar previous to absorption;

"2. That it is absorbed immediately, and unchanged;

"3. That it is not absorbed at all, and is excreted entire with the solid excrements.

"As respects the first possibility, our experience hitherto is entirely opposed to it. It is well known indeed that gum (only after long digestion, however) is converted by dilute mineral acids into grape sugar, just like other hydrocarbons. But a negative result has followed on all attempts as yet made to effect the change into that or any other substance by the digestive fluids, whether by natural or artificial gastric juice, mixed saliva or pancreatic fluid. Frerichs[*] found that gum, even if it was digested for as long as forty-eight hours, still remained quite unchanged, as was also the case when it was introduced by the mouth or through a fistulous opening into the stomach of dogs. The same experiment was made also by Blondlot.[†] I myself[‡] found that not only was gum quite unaffected by lactic fermentation, by the conversion of starch into sugar, by diastase, by saliva or pancreatic juice, but it appeared to me from parallel experiments that the presence of this substance had a protracting influence over such processes. Quantitative analyses showed the gum present to nearly the same amount after three or four day's digestion as it was before being submitted to the fermenting or digesting mixture. According to these experiments it is in the highest degree improbable that the gum is converted into sugar during digestion, even in small quantities.

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[*] R. Wagner's *Physiol. Dictionary*, iii. 806.

[†] Blondlot, *Traité de la Digestion*, p. 297.

[‡] Simon's *Archiv*. b. i., pp. 76—82.

"The other possible mode of supposing gum useful to animal life is to imagine it taken up from the alimentary canal, unchanged, through either the bloodvessels or lacteals. Now Tiedemann and Gmelin* crammed a goose with gum till its death after sixteen days, and they found in the excrements gum still unconverted, as also in the acid contents of the small and large intestines. Boussingault† gave a duck 50 grammes of gum arabic, and nine hours afterwards got 46 grammes from its fæces. He injected down the gullet of an adult rabbit daily 10 grammes of gum arabic dissolved in water, and kept the animal fed upon cabbage. The excrements preserved their usual form and consistence, but gum was readily detected in them in copious quantities. The urine passed daily was collected, concentrated, and treated with absolute alcohol; the insoluble residue was extracted with cold water, but the watery solution, even when in its most concentrated form, gave no reaction resembling gum, either with borax, or oxalate of potass, or sulphate of iron. After three days the animal was killed, four hours after the last dose of 10 grammes of gum; but neither in the chyle collected from the thoracic duct nor in the blood could, by those reagents, a trace of gum be detected. We cannot therefore hesitate to affirm that, if this substance is absorbable, it is only in exceeding minute quantities and very slowly that it enters the fluids. As to a rapid conversion into blood, that is put out of the question by the acknowledged difficulty with which in all chemical experiments gum is changed, showing itself more obstinate than any other hydrocarbon; more so for instance than sugar, which last however is still detectible in the blood, easy as it is of metamorphosis."‡

The investigations of Drs. Graham, Bernard, and Jolly, who are endeavouring to explain these phenomena by consistent laws of osmosis, are not yet sufficiently advanced or confirmed to be capable of condensation. The fact remains, that gum, in spite of its solubility, is almost if not entirely unabsorbable, and therefore cannot contribute to nourishment or in any way directly affect interstitial metamorphosis.

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* Tiedemann und Gmelin, *Verdauung*. ii., p. 186.

† *Annales de Chemie*, troisième ser., t. xviii. p. 444.

‡ Lehmann's *Phys. Chemie*, vol. 285—287.

Other substances of less frequent occurrence in nature appear likely to be classed in the same category. We may regret in gum and cellulose the loss of matter, which as hydrocarbonaceous seemed at first sight desirable for food, and the same might be said of turmeric, &c. But then we have a great gain in some of the most noxious productions of the known world coming under the same law; the fearful woorara, the contents of the serpent's fang and the insect's sting may pass through the bowels with the food, and the swallower runs no risk of poisoning, if his mucous membranes are sound. What happens if these are introduced into the circulating fluids is well known, and we may feel grateful that at all events one door of entrance to the body is guarded in the mysterious mode above alluded to.

I think, however, it is going too far to deride, as Professor Lehmann does, those practical physicians who give, as is very common in France, large quantities of gummy drinks with a therapeutical intention. It is true enough perhaps that it is not absorbed, and therefore cannot be food for combustion. But that does not prove that its qualities in acute disorders are simply negative. Why may not these unabsorbed matters have an influence, mechanical or otherwise, on the mucous membrane, shielding it from the action of oxygen perhaps, or some other agent, which, inocuous in the healthy state, is in the diseased state a source of evil? Why may not they take the place of the mucus in its prophylactic duties, covering the papillæ instead of the shed and unrestored epithelium? They may thus be of the importance to the practical physician, though only acting in an humble mechanical way.

Insoluble and unabsorbable articles act also as diluents by being mixed with other food. They enable, in fact, highly nutritious food to be submitted more gradually to the mucous membrane, so as not to oppress it with a sudden excess of riches. So that though useless themselves they augment the wholesomeness of valuable aliments. Those who have been accustomed to a diet containing a considerable proportion of cellulose or woody fibre, suffer from its omission. For example, the Finn recruits raised in country places, where they have been used to flour in which a large proportion of bark is ground as a measure of economy, are made ill on coming to head-quarters by the use of too pure bread.* It is most likely the mechanical division of the gluten effected by the bran which makes brown bread or seconds more digestible by some persons than white bread. It is a fallacy to suppose that it acts as a purgative, for such is not the case; the number of stools or the quantity of fluid in them is not increased; and though in truth the amount of solid matter passed is greater, it is only in proportion to the additional unabsorbable material which has to be rejected. But the mechanical division of the nutritious substance dependent on the husks ground up with it is quite sufficient to account for the benefit observed to accrue; and we shall, I think, find the appreciation of the principles on which we recommend it no slight guide in selecting the cases likely to derive advantage from brown, maize, or other forms of diluted bread.

A considerable amount of obscurity which attends the subject of GELATINE, makes it indeed interesting, but difficult to classify. It resembles the substances which we have been reviewing in not being contained in the typical food of mammalia, and in not being absolutely requisite, so far as we know, for their existence. But it has the peculiarities of being more like, in composition, to the component parts of the animal body, consisting, like them, of an organic compound of the four elements, and in being, by very simple chemical processes, derived from them.

Papin, in 1681, proposed to Charles the Second the scheme of extracting gelatine from bones for use as food. He professed in this way to make three oxen go as far as four, and so to increase by a third the material wealth of the country. But those were days when wit was mighty, and a petition tied round the neck of one of the monarch's spaniels, praying him not to rob his poor four-footed subjects of their lawful perquisite, overthrew the philosopher's proposal. The subject slept till towards the conclusion of the last European war, when D'Arcet again brought it forward, proposing to feed the poor cheaply on this diet. Hence the origin of the famous "Commission on Gelatine" appointed by the French Academy, who, after long delay, reported in 1841 through their foreman, M. Magendie, that giving the poor gelatine was just equivalent to giving them nothing at all.

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* See *Quarterly Review*, Jan., 1854, in an article on Finland.

With respect to these two opinions it is to be observed that the first, which asserts the capability of gelatine as a sufficient diet, in fact a "complementary food," is grounded upon no experimental basis at all: the second, which pronounces it useless, is deduced from certain experiments on dogs, in which the animals fed on gelatine alone died as soon as if entirely deprived of food. These latter experiments show indeed its insufficiency alone, but not its uselessness in combination.

There is however a middle opinion, which has led to the position in this volume assigned to gelatine, which suggests that though not required by the animal organism for the support of its parts, it may yet aid other articles of diet in nutrition, and may be what is here called an accessory food. This seems to be the fair deduction from the experiments of MM. Edwards and Balzac, who found that dogs fed on wheaten bread mixed with gelatine did not lose so much weight as dogs fed on wheaten bread alone.[*] M. Magendie, too, himself reports that when fed on bones, and not the glue extracted from them, the dogs kept alive for three months.

Dr. Bischoff has made an attempt to discover the working of gelatine in the system by feeding a dog on it with fat and potatoes, and observing the different quantities of urea excreted by the kidneys under this treatment, and when he was fed on potatoes and fat alone. The urea was indeed doubled in amount, but the experimenter confesses that in this case it is not at all certain that the destruction of the tissues was hastened, because the urea might have been derived from the immediate consumption of the nitrogenous article of food by respiration. His experiments are little more than negative.[†]

The experiments of Drs. Bernard and Barreswill, made with a view of investigating the further history of gelatine after its absorption, by injecting it into the blood of animals, have not been confirmed by Dr. Frerichs, and the subject is still as obscure as ever.

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[*] *Annales des Sciences Naturelles*, Juillet, 1832, p. 318.

[†] *Der Harnstoff als Maass des Stoffwechsels*, von Th. W. L. Bischoff. Giessen. 1853

What however we may consider as real ground gained are the following propositions:—

1. That gelatine is shown by its absence from milk to be unnecessary for the support of the animal body.

2. That, as it is required for the growth of cartilages, sinews, &c., it must be formed from other nitrogenous foods, viz., the albuminoid matters.

3. That as it does not alone prolong animal existence, it cannot replace albuminoid matters, that is, it cannot be converted into them—in other words, albuminoid matter may be turned into gelatine, but gelatine cannot be turned into albuminoid matter.

4. Its failure to prolong life leads to the conjecture that it does not arrest interstitial destruction.

5. However, mixed with other food, it makes it go further, and be more sufficient for the support of life.

It is, therefore, a true economy which puts gelatine in its various forms into soup or other diet intended to supply the deficiencies of those imperfectly furnished with the necessaries of life: that is to say, if it can be obtained in a cheap shape. But at the same time we must be careful that it is not used in such excess as to fill up the room required for more worthy claimants of attention. When employed in such excess it is apt not only to weaken the individual by its insufficiency as an article of diet, but it causes also diarrhœa, whether by acting as a foreign body, or by some spontaneous decomposition. Hence the unwholesomeness to healthy stomachs of dishes containing a great quantity of gelatine or chondrin, such as mock-turtle soup, calves'-foot jelly, and so on. While at the same time to invalids they often fulfil very important indications. In the first place they dilute nutritious matter so as to render it capable of being gradually absorbed; then, again, perhaps they line the irritable membranes with a slimy coat, taking in fact the place of healthy epithelium; and it is not impossible that in some cases they are beneficial, because *not* nutritious, onstituting in fact an agreeable mode of abstaining from food.

BOOK II.

CHAPTER I.

HEALTH AND DISEASE.

The artificial boundaries of chapters and pages separate physiology and pathology for the convenience of readers; but it tends to false views of Nature's works, and bad practice in our profession, to suppose them different sciences. It is a fatal error to do or to say anything which can lead to the idea, that in health one set of laws are exhibited by our bodies, and in disease another set; or what is still worse, that these laws are in opposition the one against the other. The more man learns of Nature, the more convinced he becomes that one mode of action is followed throughout—that here there is not, as in the moral world, any contest of Ormuzd and Ahriman, any prevalence now of the evil principle now of the good; but that everything is as it came from the hand of its Maker—"very good."

What, then, is disease? Its etymology best explains: it is a state of things in the body which produces a want of comfort to the mind, renders it inefficient for the mind's purposes, or shortens the connexion of the two—the material life. This inefficiency, this want of power to do what the sane mind thinks it has a right to require of it, may be referred in some examples wholly to *external causes*, in some wholly to *original formation of the body*, in an overwhelming majority to a *combination of the two.* But what happens in every instance is in obedience to the ordinary laws of physiology—chemical, mechanical, mixed, or unassignable (commonly called "vital"), as the case may be.

In the *first* category may be included all mechanical injuries and poisons, with their consequences. A man has his skull fractured; a piece of bone presses in upon the brain; he lies in a state of coma: you raise the piece of bone, and he revives. Now, coma is certainly a diseased condition; yet it is as much a part of man's nature, as truly physiological that he should be comatose when his brain is pressed upon, as it is that he should be hungry when he has been long without food. Or, in obedience to the calls of philanthropy, a healthy individual visits the putrid laboratories of miasma in the sinks of a crowded city, and has a typhus fever in consequence. His sickness is more directly in accordance with physiology than the half-health of the sallow inhabitant of the place, whom long habituation has deprived of the vigour sufficient to develope the acute attack.

Under the *second* may be classed, not only what are ordinarily termed malformations, but also cases of imperfect balance between the organs, though in shape, size, and development they may be separately efficient, and all the obscure congenital tendencies, which become developed as life goes on, probably in consequence of this imperfect balance. The machinery of the animal body is not constructed to last for ever, and some parts of it are so made in different individuals as to wear out sooner than others. Hence we have various degenerations, of a general or partial character, by which the man, even without any external influence, falls like ripe fruit into his mother's lap, sooner or later than the completion of his average threescore years and ten. If the degeneration is general it is called "decay of nature;" if partial, the balance of health is more disturbed, and it is disease of the heart, kidneys, &c.; thus forming a class of cases by which this category slides into the following one. But here no new phenomena are brought to view. The same continual change of tissue, which in the exactly balanced organism goes on slowly wearing it out from birth to ninety, consumes it by fifty; where the heart is so constructed originally that the hardening of its valves and the thickening of its walls, usually developed in old age, comes on earlier in life; or where the arteries, kidneys, stomach, or other viscera become thus anatomically altered. Or the provisions for metamorphosis may have been so arranged as to get less and less equal to their task for a series of years, till at last they are unable to do it, and instead of fibrous tissue of definite shape, there is developed formless tubercle.

But in strict truth, it is very rare that pure cases of disease arising solely from original structure are found. Persons of imperfect frame are naturally more liable than others to external injuries: the unequally balanced organism is more easily deranged by cold, heat, excesses, blows, &c.; and hence almost all our patients suffer from the physiological phenomena consequent on a *combination of their special form of a body with external circumstances.* Three persons are equally exposed to the poison of scarlet fever: one, having had it before, or for some other unexplained reason, is unaffected by it; another, being so formed that his kidneys are easily deranged, has the disorder, followed by albuminuria and dropsy; the third, whose weakest point is the metamorphosis of tissue, has that function so thrown out of work by the poison, that in future he grows tubercle instead of fibre in some part. Four men are working together in one well, exposed to cold, wet, and impure air; one, who has long had slight renal degeneration (whose kidneys are in fact older than the rest of his body), gets anasarca; another, who from birth has found a little difficulty in converting uric acid, accumulates it in his blood, and is laid up with gout; the two others are able to resist all the noxious external influences. In point of fact, the failing function becomes itself a foreign power, which, united with the terrestrial ones, is the formal cause of the disease; and it would have been a departure from the observed laws of physiology if these events had not happened.

Diseases therefore, and more especially chronic diseases, must be treated not in lots, according to their nomenclature or as if they were the progeny of some evil power, but according to the mode in which each individual is affected by the union of outward circumstances with the peculiar form of his body. We must treat the man and not the ailment, or we are nearly as likely to make matters worse as we are to make them better. And we must act with the conviction that everything happens, both as respects the patient's body and the drugs or discipline which we adopt, according to identically the same laws which are to be observed in health.

The only systematic nosologist who has been far-sighted enough to anticipate a doctrine which is just beginning to acquire a proper influence, is that great but incautious genius, Dr. Darwin. His *Zoonomia*, or *the Laws of Organic Life*, contains descriptions of diseased as well as of healthy actions. "Hunger" is included in the same genus with "heartburn," as arising from decreased actions of the gastric membrane; "dry tongue and fauces" in the same with "gall stones" and "costiveness," inasmuch as in each of them the balance between the supply of fluid and its removal by the absorbents is disturbed. I quote here striking and semi-paradoxical instances on purpose, for I am not undertaking the task of advocating Dr. Darwin's classification (though I think I should like it much better, and should easier overlook its defects, if I undertood it);* but I simply wish to assign to him the merit of broad and philosophical views on this great question, as on many others which he has handled. He has seen and expressed the truth, though imperfect knowledge kept him from an application of it to details so useful as we could make now, and far, very far, short of that which may be effected by the next generation.

The important problem for medical science to solve is to know the visible signs and indications of the various combinations of different forms of organs, and their functions, so as to modify, in the way to suit each combination best, the circumstances subject to our will. A good many we do know, and find them most invaluable in practice. We observe, for example, that a man's urine contains a trace of the albumen of the blood, and conclude from hence that external circumstances or original constitution have caused the kidneys to become degenerated. We know that in this case the skin, from the partial relation of its functions to those of the kidneys, cannot bear exposure to cold and wet like other people's; so we clothe our patient in flannel, give him baths and rub him, and keep him in a drier and warmer air than is good for healthy persons. If he is wise enough to follow advice, he may avoid dropsy and other diseases which are the physiological consequences of his bodily structure. Or we see a lad growing up with that cast of countenance and figure which indicate a liability to tuberculosis: we persuade his friends to send him out as a whaler, to have a rough life, but plenty of good air and a good digestion in the South Seas: he passes the critical period of early manhood unscathed, and lives to tell grandchildren of his adventures. His brother is apprenticed to a tailor, injures his weak growing viscera by an unnatural posture in an impure air, and dies at twenty with tubercles in his lungs. We see a lady with languishing eye and dilated pupil, and recognising that peculiar condition of the nervous system called hysteria, know that whatever illness accident may inflict upon her will be largely coloured with symptoms out of her tendency. No sane physician talks about removing these habits of body; it would be something like curing an ugly nose or too short legs. What he has to do is to regulate external circumstances so that they may not develope themselves into diseases, or when diseases do arise, to take the constitution of the individual into account in diagnosis and treatment.

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* Tout comprendre, se serait tout pardonner.—*Corinne.*

There is nothing in which the present advancing state of rational physiology and rational medicine will benefit mankind more than in adding to our acquaintance with what may be called the internal features of the body. It may be stated without the slightest hesitation, that every one's viscera differs from his neighbor's as much as his face and hands do, and from their greater extent admit of a greater variety of combinations. We are gaining in this way a knowledge of what are in one sense *incurable* states, but the more familiar with them we are, the better we are able to cure the diseases of which they form part, to prolong life and alleviate pain.

The attribution of ill health to a combination of a peculiar bodily form with external circumstances, explains a great deal of the undoubted fact of the hereditary nature of so many diseases. No one who has looked over a family portrait gallery but has smiled at the constant reappearance, sometimes with the interval of a generation, of certain tricks and distinctions of feature—some twist of the nose or slope of the eye, or "villainous hanging of the nether lip." Sometimes, too, the peculiarity is not one brought from the cradle—the son's scalp gets bald in an odd shape at fifty just in the same way as his father's did at fifty; or at seventy the same cervical vertebra fails, and the same angular poke of the head is seen for several generations; or the whole family, slim in youth, grow obese at the same period of life. Can we wonder, then, that the invisible configuration which causes a want of balance between liver and heart, or lungs and skin, &c., &c., making one person more apt than another to suffer from accidental exposures, should be equally a heir-loom? Is it any longer strange that a child should be born with a tendency to get tubercles in his lungs at thirty-five, derived from his father, who at thirty-five became so affected? Whether the disease was already developed in the parent at the time of the child's conception can make no difference; it is the *tendency—the form of body thereto disposing*—which he transmits to his image, and not the actual tubercles.

In no functions of the body is this hereditary nature of peculiarities so marked as in those which minister to digestion. Particular articles of food and particular medicines disagree with a whole family and their descendants in an almost ludicrous manner. Sometimes the tabooed articles are such as are in themselves not much favoured as a general rule by weak stomachs—such as roast veal, or crab, and the like; sometimes the idiosyncrasy assumes a more special form. I know a very robust household to many members of which rhubarb, however furtively administered, in pill or otherwise, always causes vomiting. Butter, cheese, fish, sherry, &c., &c., are in other instances acknowledged family enemies. How can this be except from some arrangement of the digestive organs transmitted from parent to offspring as correctly as the external features? And does not the fact of these peculiarities being transmitted along with and running into those which are universally acknowledged as physiological—such as national, tribual, or family features—show that they are part of the same universally applicable laws?

This seems the place to make a few remarks on the distinction made between "functional" and "organic" disease, to say how far the idea expressed by the division appears to me to be true, and therefore how far practically useful and important. That disease should result from the visible deformity of some organ is comprehensible enough; that shortness of breath should be the consequence of the lungs being stuffed up with tubercles, congestions and dropsy of an imperfect heart, vomiting of a cancer of the pylorus. Here the functions belonging to certain organs are irregular, because the organ is irregular, and the disease is named according to the part affected.

But a great number of cases occur where a function may be so disturbed as to cause illness and even death, but yet when we come to examine the organ which it is principally concerned with, nay sometimes when we examine all the organs of the body, they are what is commonly called quite normal. We cannot here name the disease from any part, without bringing our imperfect theories too prominently forward, and attributing to them too great certainty. Such disorders then are named "functional," and are distributed according to the function affected. Asthma, where it gets quite well, or no anatomical leison can be discovered, is called a disease of the "Respiration:" colic, imperfect secretion of bile, excess of gastric mucus, diarrhœa, constipation, &c., without any known alteration of form in the viscera, are called diseases of "Digestion." The assignment, then, of a disease to the category "functional" is in one sense a confession of ignorance, and as such most honourable and praiseworthy. It is as much as to say we can go, or we choose to go, no further than the statement that such and such a duty of the body is ill performed. But if we intend such a classification to mean that changes of function occur without any change of substance, that which matter *does* is altered without an alteration in what it *is*, I think we are proceeding on a most unwarranted assumption.

I feel there is some danger here of running into verbal refinements of quiddities and qualities, and will therefore use illustrations rather than abstractions. A person has small-pox or is vaccinated, and afterwards not liable to the infection: I conceive that some *thing* is by the small-pox or vaccination added to or taken from the body, which renders its atoms different from what they were before, either in number or arrangement, which number or arrangement is less susceptible than ordinary of the physiological action of the virus. There is a cognizable permanent change of the quality of his body. Or he catches a cold in the head, or a typhus fever. I cannot imagine in these cases any other state of things than an alteration in the atoms of the body, either by the addition of some deleterious agent or by the conversion of some element of the body into a a deleterious agent, which succeeding influences are able so far to remove that no perceptible trace remains. The change may not be permanent in any degree cognizable by our senses, but yet it is easier to imagine that the body is different from what it was before, than that it is the same. In all cases of corporeal derangement I conceive there is an addition or subtraction, or change of arrangement of matter, which is the formal cause of the change of function; and that our knowledge of the performance or transitoriness of this change is dependent on our greater or less acquaintance with the elements involved.

We do not in ordinary life deny the addition or subtraction of substance simply because our senses are unable to appreciate it. We are ready to acknowledge that every shower which has beaten on Westminster Abbey has washed away some portion of the stone, though it is only after generations have passed that rounded angles and deformed crockets are recognised by the eye. We can easily imagine superior beings by whom the exact effect of each drop of rain could be estimated, and for our parts are content to infer from the ultimate result the reality of such inappreciable change. Just so in the animal body we may picture changes occurring with each motion and with each exercise of function, which render the body different from what it was before, and different from what it would have been had the motion or function been dissimilar. Indeed our experience of matter makes it impossible for us to imagine any other state of things.

I have illustrated rather than attempted to prove the above opinion, because the proof being cumulative would fill volumes, and be imperfect at last; and also because when it is fairly drawn out and plainly expressed, I do not know that any one will advance a denial.

Yet if this be conceded, what becomes of the contrast of "organic" and "functional" diseases? Both equally depend on change of matter, and of neither can we say how far or what part of that change is permanent; the only difference seems to be, that in one we can make a drawing or a chemical analysis of the change, and say where it is; in the other our ignorance prevents our doing so. When therefore the word "functional" is used in the following pages, as it often will be, let it be considered to mean no opposition to "organic," but simply a confession that the changes of matter preceding and accompanying it are not discovered—that our knowledge of the subject ends with the perception of deranged function. Constant progressive change, proceeding in a straight line toward final dissolution, must be looked upon as God's law for all organic individuals. Whether the march towards dissolution is quicker or slower, depends partly on the original form of the machine, and partly on the external circumstances to which the introduction of moral volition into the universe subjects it. In either case the progress is according to the same laws of physiology.

How then is a boundary line to be drawn between health and disease? Simply by looking to the moral or non-material relations of the individual. When able to carry on the duties its original structure fitted it for, and not tending to dissolution earlier than the average, it may be said to be in health; when the contrary is the case, it is diseased. When a man's body is no impediment to the mind's performing (as Milton says) "justly, skilfully, and magnanimously all the offices of peace and war," and is not abridging its usefulness to mankind by premature decay, he is "well;" when otherwise he is so far forth "ill." I can find no other definitions of health and disease, though more apparently philosophical, which are not impracticable, partial, and untrue. Any distinctive differences or classifications founded on presumed contrasts in the nature of their laws must lead to false views being grounded in partial truth.* Any narrowing of the terms to suit imperfect knowledge renders them less practically useful. We have no right to withdraw words from ordinary acceptation, clip their meanings, and then tell the vulgar that they imply one thing in science and another in the world. Disease is best used as a relative, not an absolute term, with a reference to moral circumstances as a moveable boundary. Its phenomena are those of organic life, placed in a separate category as being inconvenient to the non-material part of the individual.

By disease then, in one sense, is implied any process in the body which is inconvenient to the individual—any "*morbid*" process. Now a morbid process seldom occurs singly: when one member suffers, all the members suffer with it; and hence there occur groups of morbid processes, each group constituting what is usually denominated "*a* disease." And according as these groups more or less resemble one another, so divisions and arrangements of the morbid affections of the body are made. These divisions are sometimes natural; as for instance when a group of processes, some of which may be present and some not, arise from a common cause, such as a morbid poison in the eruptive fevers. Sometimes they are purely artificial, such as the division of indigestion into "tonic" and "atonic:" the tonicity or atonicity being in the person and not in the disorder, and there being no original and innate difference between the two. The former sort of divisions are clear and marked, the latter cannot be so, for there are all grades of intermediate forms necessary between one and the other.

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* Unless of course precautions are taken. We may adopt for the purpose of teaching any classification which best prevents repetition, and do no harm, if we warn our hearers. If they have time, the more classifications pupils understand the better, for there is none, except the alphabetical, which does not embody some truth.

Equally artificial and confusing to true pathology are divisions according to other accidental lesions with which a certain derangement may be joined; such for instance as talking about "hysterical" dyspepsia, or "uræmic" dyspepsia, when in fact it is the person is hysterical or uræmic and not the disorder.

To advance true pathology and rational therapeutics, attention must be directed less to the divisions and subdivisions of diseases, and more to the morbid processes which constitute them. In the use of medicines especially is this desirable. Specific remedies obviously are applicable, under any circumstances, only to those natural groups of morbid processes which are due to a common cause—to some poison introduced into the body; and we have but little reason for hoping to increase much our wealth of this class of antidotes. The great bulk of our medication cannot be of a specific character; it must be rational and effectual just in proportion as we are able to see in each individual case the morbid processes broken up, as it were, and separate from one another, and to weigh their manifestations against the counteracting agents which we possess.

With the design of keeping in remembrance that pathology is merely complementary to physiology—that is, completes the collection of arranged facts which constitute the laws of organic life—I have arranged the chapters and minor subdivisions (and as far as practicable, the nomenclature) in this book, so as to correspond with the former one. To carry out this arrangement, and—not from any affectation of singularity—to show a sense of the importance of studying diseased processes with a view to healthy ones, and not from a proneness to new terms, the systematic names of a few disorders have been replaced by simple descriptions. For example, "follicular gastric dyspepsia" is here called "mucous flux of the stomach." But I have been careful not to manufacture any novel words from dead or living sources, and have adhered to those established in classical English.

CHAPTER II.

CHANGES IN THE PARTS OF THE ORGANISM CONCERNED IN DIGESTION, WHICH ARE COMMON TO THE WHOLE ALIMENTARY CANAL.

THIS subject will be taken up in the same order, and with the same divisions, as in the First Book; so as to carry out practically the strict relationship which has been stated to exist between physiology and pathology. The chapter was divided into seven sections, which discussed separately the normal condition of the several constituents of the alimentary canal; viz., the epithelium, the bloodvessels, the mucus, the water, the nerves, the muscles, and the peculiar secretions or media of solution. The alterations in them, commonly called morbid, will be discussed in the same order, and remarks will be made upon principles of treatment dependent on the state of these common parts.

Although the alterations in these parts are separately discussed, it is not intended to be implied that they are found separate one from the other. It is almost as unlikely that the bloodvessels should be morbidly affected without the aqueous circulation being disturbed, or the mucus altered in quantity without the epithelium and the blood, as that these constituents of organs should exist in the healthy state independent of each other. The disease then of each one is an abstract picture; and the treatment must never be taken in hand without a remembrance that all the tissues suffer mutually together.

But there is a peculiar practical value in this abstraction, and if rightly used it tends to make our treatment of disease more rational and efficient. Though each morbid process is incapable of existing independently in a separate tissue, yet as a matter of fact one is generally predominant, and it is almost impossible to find a case in which the alterations of sanguineous circulation, of epithelium, of mucus, &c., are so nicely balanced that one does not attract attention more than the others. The predominance may be secondary or primary, but it exists; and it is of the utmost consequence that it should be made individually the subject of reflection. According to the predominance of the affection of one tissue or the other, the case becomes, as respects treatment, a specimen of a different disorder, and must be so managed if we wish to be successful, and to avoid the heavy burden which must be laid upon the conscience by a routine practice according to nomenclature. We have all heard the *mot* of the old physician, who said that on commencing life he had twenty remedies for each disorder, but that on retiring he had twenty thousand disorders for each remedy. He was describing the change of notions consequent on ceasing to read comments upon Nature in the dry leaves of a dictionary, or the rough outlines (alas!) of "Lectures on the Practice of Medicine," and studying it in the Great Original.* The fact is, our knowledge of the agents by which we modify disease is so limited, and must necessarily be in its infancy for so long a future period, that we cannot find medicines suited to one-tenth of the complications of morbid processes which crowd upon the unprejudiced reason of the physiological physician. He is obliged therefore, by the coarseness of his instruments, to select some prominent feature in each case, and to treat that, neglecting though not forgetting the other concomitant ones. What feature he ought to select, when he may safely neglect the concomitant ones, and when it would be dangerous to do so, he can only rationally learn by considering each tissue and function abstractedly from a physiological point of view. This is the practical value I attribute to the plan adopted.

SECTION A.—*Changes in the Epithelium of the Alimentary Canal.*

The rapid destruction of the epithelium after death prevents our gaining any knowledge concerning the changes which occur in it during disease from morbid anatomy. During life, however, there is one part of the digestive canal—viz., the mouth—where we can with ease observe the most minute alterations; where, in fact, these alterations are exhibited to our eyes in a magnified, exaggerated form which cannot escape notice. The state of the mucous membrane in the mouth, especially of that part of it which constitutes the tongue, has been, from the earliest times of which we have record, a guide to physicians in the diagnosis, prognosis, and treatment of disease, both acute and chronic: it is universally acknowledged as an index of the internal organs.

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* "For Harvey sought for truth in truth's own book,
The creatures—which by God himself was writ;
And wisely thought 'twas fit
Not to read comments only upon it,
But on the *Original* itself to look."—COWLEY.

Much mystery has been made about this, and mere empirical observation and memory can only tend to increase the mystery and obscure the truth. The examination of the tongue has been made a special art, or still worse, has been represented as a kind of instinct which years and habit can alone give to the physician, and whose rules and mode of argument are incommunicable to the uninitiated. Such a claim to be allowed to arrive at a conclusion by an inexplicable chain of deduction, may indeed be permitted to ancient nurses or other ill-educated persons, who are incapable of building a bridge from their ideas to ours; but for one accomplished medical man to say to another that he has arrived at a diagnosis, or recommends a treatment, or prognosticates a result, without being able to give a reason in words, is in the year 1855 a proof that he is either making a careless and lazy guess, or is weak enough to be ashamed of saying he does not know. In the present day, the diffusion of science has enabled us all to have a simple common language, in which we can communicate and lay before one another our ideas; so that in consultation together there is no excuse for not understanding the full strength and weakness of the arguments by which each one has been led to his individual conclusion. Let us then have done with arts and mysteries, and when any visible sign is quoted as a proof of the existence of some state of things not obviously associated with it, let us demand to hear the connexion of the two scientifically traced: or if that cannot be done, let us know on what ground, statistical, empirical, or hap-hazard, the evidence is based.

When, then, we acknowledge the tongue as the index to the condition of the internal organs, let us do so on the understanding that it is possible to show a physiological association between the two—that their states are either mutually interdependent, or derived from some common cause. The time is past for assigning one sort of tongue to inflammation of the lungs, another to complaints of the liver, or of the heart, or of the brain, and so on, and refining upon our subdivisions so as to force them to accord with Nature. The tongue *never* to the rational physician, indicates directly the localization of disease in a particular organ; it indicates simply a certain condition which may or may not depend thereon; and he rightly requires further phenomena to assist a localizing diagnosis. But should he be obliged to stop here, from want of further aids to knowledge, he is still able to apply general treatment to the general condition, and can delay special treatment till he is able on good grounds to form a special diagnosis.

Almost all derangements of the body affect in some way or another the epithelium of the digestive canal. This part then, by its index, the tongue, declares in signs more or less clear what is the general condition of the whole individual.

The general condition again is reacted upon by the state of the mucous membrane, the arrangements for absorption influencing very powerfully the whole living being. So that not only is the tongue a guide to the knowledge of the actual departure from health, but it gives hints also how to modify external circumstances so as to suit this deviation.

This then is the order to be adopted in the section before us. First, I will detail the mode in which the principal disordered bodily states affect the gastro-intestinal viscera and are declared in the tongue; then the inferences as to the reaction of these affections on the general health; and afterwards point out the influence which these considerations should have on the treatment of disease. Succeeding chapters will apply these data to various parts, and discuss the modifications introduced into the treatment by the different localities of those viscera, where the phenomena are chiefly manifested in individual cases.

The following list seems to include all (certainly all the chief) classes of morbid phenomena which are manifested externally in the state of the epithelium; viz.:—

1. PARALYSED OR ARRESTED SECRETION.
2. THE CATARRHAL STATE (ACUTE).
3. MUCOUS FLUX (CHRONIC).
4. EXCESS OF EPITHELIUM (CHRONIC).
5. THE INFLAMMATORY STATE (ACUTE).
6. THE ANÆMIC STATE.

The above classification is purely artificial, as the various states are by no means inconsistent with one another; indeed, they may exist at once in several parts, some of them at once in the same part, without difficulty. The order, too, is conventional, merely for the sake of convenience and to avoid repetition, and may be inverted or changed at will.

1. PARALYSED OR ARRESTED SECRETION, either from a supply of poisoned blood or defective innervation, such as takes place in low zymotic fevers, or in the secondary adynamic states of inflammatory diseases.—Here the tongue has a full blood-colouring, perhaps even is of a tint darker than natural in places where the skin is transparent. It has at first a sticky, opaque epithelium upon it, which is very imperfectly supplied with moisture; indeed, the scales seem to have scarcely any power of gaining moisture for themselves, and if the mouth is left open, and the saliva does not arrive at the tongue, the draught of air quickly dries it up. The sluggish, morbid blood oozes out through the altered or cracked coats of the capillaries; and while its presence is declared by the albuminous serum in the intestinal excretions, it dries on the tongue in the form of a reddish-brown coat. The deficiency of fluid excreted sometimes allows it to accumulate in great quantities, especially tough when much blood is mixed with it; sometimes it falls off in flakes, leaving the tongue raw and red. This rawness is a bad sign; for it shows a tendency in the mucous membranes to lose their life and slough, leaving holes which constitute the "ulcers" of typhus fever.

Remarks on Treatment.

This paralysis of the mucous membrane and poison of the blood we know by experience lasts a limited though not exactly defined time, and then gives place to a resumption of the ordi nary action. During the time it lasts, food in the usual form cannot be absorbed; it is changed into chyme in quantities insufficient for life. But if the albuminoid compounds are given in a dilute form suspended in water, they seem capable of being absorbed. Hence the peculiar suitability of beef tea, broth, and the like, for typhoid conditions. A certain amount of gelatine in the liquid guards the mucous membrane from irritation, but at the same time is innutritious, and must delay absorption.* We should therefore, when the mucous membrane may be supposed to be coated with unshed epithelium, let the beef tea be watery, and rather an infusion than a decoction; while it may be strong and longer boiled, so as to form a firm jelly when cold, if the raw tongue denotes a raw intestinal canal.

Alcohol and ethers stimulate the nervous energy, and enable the supply to be taken up. At the same time they limit destruction, and so prevent what remains of the tissues from passing away so rapidly as they might do.† Sugar has the same limiting influence in a minor degree, especially over the bony tissues.‡ And the experience of all ages shows that a mixture of these articles—alcohol, flavouring ethers, sugar, and water, such as is found in wine and malt liquor—is the most digestible form in which they can be given, both in health and in disease. Combined, they are more wholesome and efficient than separate, act together when given in quantities which would be inert when alone, and seem therefore mutually to assist one another's absorption. Thus is to be explained the fact, which all those of most experience in hospital practice will confirm, that porter will often, in low states of the system, give an energy entirely out of proportion to the quantity of alcohol it contains, and that brandy and spirituous liquors are decidedly inferior agents to port wine in low fever. By these means we are able to postpone the peril of immediate death. And inasmuch as the nature of the fevers is to run a certain circular course towards health, and so to end if no untoward events or death prevent them, it is obvious that such postponement is the most important part of the treatment, and in a great many cases will alone suffice. Treatment auxiliary to it is valuable; and treatment which has in view the evacuation of effete tissues, such as the administration of mercury and salines, may be made not inconsistent with it. But if any of these means interfere with the great end of supporting the vital powers, they are decidedly objectionable.

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* See before, p. 220.

† See pp. 190–196.

‡ See p. 199.

Such is an example of the indications afforded by the tongue in low fever.

2. THE CATARRHAL STATE.—The phenomena of catarrh are most familiarly exemplified in the well-known cold in the head or influenza of the respiratory passages. It occurs at times in all parts of the mucous membrane, but is more disposed to attack some special systems of the tissue than others. The order of frequency with which they are liable may be roughly stated as follows: first the respiratory tract, then the alimentary, then the genital, and then the urinary system. But not only are different systems, but also different parts of the same system, disposed to catarrh in various degrees. So for instance in the alimentary canal, catarrhs of the stomach and ilia are the most frequent; catarrh of the colon is rare, and rarer still catarrh of the œsophagus.

The physiological characters of catarrh are—

1stly. Congestion—just as takes place in the first stage of phlegmonous or fibrinous inflammation, but without the throbbing which is there felt.

2ndly. The secretive activity of the affected part is increased after a very short interval of diminution. Herein is a striking difference from ordinary plastic or fibrinous inflammation, which continuously diminishes the true secretion.

3rdly. The secretion is altered in quality as well as in quantity. Thus in nasal catarrh an irritating, watery, salt serum often flows, excoriating the tender skin by dissolving and washing away its epithelium or epidermis. At other times it is thickened mucus that is poured out; and if we examine this mucus with a microscope, we find that its opacity and altered colour are derived from globules of pus, associated with a vastly increased quantity of of epithelial scales, granular nuclei of epithelium, and various granular and globular bodies of unknown origin, and in many cases small flakes of fibrine.

Again, in febrile gastric catarrh the formation of epithelium in great quantity and of an inefficient character is shown by the yellow coat on the tongue, its bitter taste, and increased adherence.

Thus we have three tpyical points in catarrh, according to the predominance of which it takes its character as *Serous*, *Muco-purulent* or *Epithelial;* each sort combining with or running into and interchanging with the others.

For example:—*Epithelial gastric catarrh* is characterized by a thick yellow coat on the tongue, an incapacity of the stomach to digest its contents, and an irritability of the viscus, which tends to reject by vomiting those undigested contents. At the same time the bile is formed in its usual quantity, is drawn by the effort of retching into the stomach, and thrown up with the food and mucus. Or else passing downwards, and being unabsorbed by the mucous membrane, it is excreted by stool. Here we have the ordinary "bilious" attack, as it is called.

When the formation of peculiar epithelium is not so predominant, but common *mucus* is poured out in excessive quantity, the symptoms and the anatomical changes approach much nearer to common inflammation, the tongue is white, and not nearly so thickly coated. It is moist or even wet, but still towards the later stages of the complaint is apt to become unnaturally clean, as in the typhoid state. There is here considerably more febrile reaction than in epithelial catarrh, and you have the group of symptoms called "gastric remittent fever." When vomiting occurs, you see the mucus rejected which is formed in large quantities in the stomach, or it is passed in thick stringy lumps from the bowels.

It may be a suggestive subject for contemplation to inquire whether catarrh is really an increased or an imperfectly displaced secretion. By far the most common cause of it is an arrest of the usual functions of the skin by cold or heat: the external sweat ceases, and the epidermis is not so freely shed and renewed as it should be, the moist suetty dandrif no longer greases and polishes the roots of the hairs, the head is dry, and the skin choppy. Are not the internal surfaces in the mean time replacing this by pouring out water and imperfect epithelium in the shape of mucus? We are all familiar with the thin transparent skins and the clean scalps of those who are suffering a chronic increase of the mucous secretion from local irritation of the air tubes in consumption—is not this a converse case in point?

4thly. In catarrh the sensibility of the nervous system of the mucous membrane is increased, so that there is a pricking feeling in those parts which partake of common sensation, as in the nose for instance, and reflex action in those which do not, as cough in pulmonary catarrh, vomiting in gastric, diarrhœa in intestinal catarrh. .

5thly. All forms of catarrh have a tendency to periodicity; they remit in the morning and get worse towards evening each day, and if entirely uncomplicated with chronic states end within a limited time.

Remarks on Treatment.

The indications of treatment in all sorts of catarrhs are,—

First, to give the mucus poured out a good opportunity of escaping from the system. In pectoral catarrh its accumulation excites cough, and it is well known that to check that cough by voluntary efforts or opiates is bad practice. The same principle must guide us in abdominal catarrhs; vomiting and diarrhœa are frequently the result, and to arrest them is not wise; indeed if they do not arise, it is advisable to give emetics and purgatives. The latter especially cause so little inconvenience, and are such a decided relief to the discomforts felt in the abdomen, even when the stools are more frequent than usual, that it is better to give them in all cases where there are not obvious indications to the contrary. In epidemic catarrhs particulary, warm purgatives may be set down as the main way by which medical men should interfere—as the only universal rule of treatment.

And we should not be deterred by the apparent debility of the patient; for experience shows that renewed strength follows evacuation by this means. The reason of which probably is that the mucous membranes are enabled to take up stimulant and nutritive substances, to which entrance had previously been denied by the thick layer of the secretions.

Another indication in catarrhs is a full supply of diluent drinks to keep up the intermediate circulation, which must be interfered with by the amount of mucus thrown off, and by the diarrhœa which washes that mucus away. Nature teaches this by the instinctive thirst, and we should not let any superstition or false theory of the non-medical friends prevent its gratification.

Abstinence from solid food is another indication of which a hint is afforded us by instinct in the loss of appetite. But so little is this understood by patients, that they often insist upon stuffing themselves with meat, in the vain attempt to supply that strength the loss of which is due to the disease.

3. MUCOUS FLUX.—Acute catarrh is *allied* indeed to mucous flux (or as it is sometimes called "chronic catarrh"), but it does not appear that it often *leads to* this latter state, which commences more commonly gradually and independently of previous acute catarrh, especially in the stomach and intestinal canal. It is essentially a chronic state, not tending to run a certain circular course and get well, but to proceed onwards in a straight line from bad to worse. "Chronic catarrh," or mucous flux of the stomach, produces a smooth, glazy, wet tongue, with the white epithelium more or less predominant over it. Sometimes it is very white, but not thick.

The mucus prevents the solution of victuals in the stomach, their absorption in the intestinal canal, and the orderly excretion of their remains from the colon. But these and other symptoms will be noticed more properly under the head of "The Mucus" in a succeeding section, as they follow wholly on the physical qualities of that secretion after it has separated itself from the body and become, in point of fact, foreign matter.

4. EXCESS OF EPITHELIUM.—A more than ordinary formation and adherence of epithelium as a chronic state occurs in some persons. Their tongues, even when they are in the best of health, are habitually covered with a thick coat, sometimes yellowish and thickest at the back of the tongue, and sometimes

white and pretty evenly spread over the surface. This is usually associated with a thick sebaceous skin, and often a dingy olive complexion, but it is sometimes found with all sorts of physiognomies.

Remarks on Treatment.

It is scarcely to be called a diseased condition, and certainly does not call for active curative treatment. But you generally find the possessors of such tongues apt to suffer from weight at the epigastrium after even ordinary meals, and unable to transgress the strict bounds of prudence in diet. Smoking tobacco especially always disagrees with them, and they seldom bear opium well. Both these drugs produce a coat such as is above described, on the tongue in healthy persons; and where it exists of its own accord, they cannot be borne.

5. THE ACUTE INFLAMMATORY STATE.—Here the papillæ become swollen and prominent without shedding their epithelium. Indeed it seems to be harder and more adherent than natural, so that it forms the papillæ into short hairs, constituting the "furred" or "furry" tongue. This is a proof that the inflammation is not confined to its local site, but has affected the whole system, and the mucous membranes in particular. It is a proof that general treatment will be useful as an addition to the local.

Remarks on Treatment.

In this state the mucous membranes seem to have a difficulty in absorbing liquids, so that there is a great demand in the system for them, as is shown by the instinctive thirst of fevers. Much of the fluid taken in by the mouth not being absorbed, often passes off by the bowels, constituting a spontaneous purging. Not that this purging is hurtful or proper to be stopped, for its effects in washing away a certain quantity of the effete epithelium must be beneficial. As in catarrh then, so also in inflammations, diluents and purgatives are a rational as well as empirically successful treatment.

It is remarkable how general bloodletting will often reduce the fur or swelled papillæ, and clear away the coat or adherent epithelium from the tongue. It may be presumed that this effect on the mucous membranes arises from the removal of the stasis, or obstructed state of the capillaries throughout the body, by which removal they are enabled to carry on the work of absorption and secretion in a more normal way.

But bloodletting in excess is apt to bring on a want of power, indicated by the paralysis or arrest of action in the mucous membranes. When this is the case, we find the fur decrease on the tongue, but the coat becomes thicker, smoother, and more sticky, and acquires at the back part a brownish-white colour. This is well known as a hint to stop bloodletting and all depletion; and it is I am sure the best hint that Nature gives, for there is less chance of a fallacy in it than in any other.

The strength, emptiness, or weakness of the pulse, by which many books teach us to judge of the expediency of withholding or repeating the use of the lancet, looks well in print, but is not nearly so easy to decide upon by the bedside. The touch is a sense much more liable to be misled than the eye; indeed, unless it is specially educated, as in blind persons, it is scarcely ever trusted to alone. And when not only its obscure impressions, but the *memory* of those impressions have to decide important points (as when we try to judge if the pulse is weaker or stronger than on the previous day), a conscientious man cannot but be sensible of the extreme untrustworthiness of the reed he leans upon. In addition to this it must be observed that we have no mechanical mode of correcting the impressions of touch. The estimation of them is like comparing distances without having been used to measurement, or judging of numbers without having learned to count.

To reckon the number of beats of the pulse is also open to nearly as much fallacy. The mere fact of our examination raises it in almost everybody three or four strokes a minute, and in persons naturally nervous, or who have some reason unknown to us for mental emotion, during our examination the rise is much more. Then again morbid conditions, combined with the inflammatory state, may depress or increase its rapidity; and to take these various conflicting circumstances into calculation is a severe exercise of human ingenuity, even if we know them all, which in nine times out of ten is not the case.

The nomenclature of the phenomena of the pulse is also exceedingly defective and vague. This is partly the effect, but also in a great measure a cause, of the deficiency and vagueness of the information we gain from it. For in all sciences it is certain that accuracy of etymology must precede accuracy of research.

If any one doubts of these facts, let him ask half a dozen senior medical students to feel on successive days a patient's pulse, and set down independently their opinions about it. In most cases they will be all different, and some directly contrary.

But in the tongue there are none of these sources of fallacy. If it is recorded as rough and white one day in one note-book, and in the next is smoother, with a yellowish-brown tinge, or drier than before, there can be no mistake about the matter. To combine or confirm such information with the changes in the pulse is satisfactory; but should our impressions derived from the two sources conflict, I say trust to the tongue, and leave the pulse's faint voice unheeded.

The only really common opening for error is one which can hardly be mentioned without a smile. I mean the stain on the tongue produced by brown-coloured medicines, liquorice, or the like. A hint is enough to prevent this; it is indeed a ridiculous and small thing—unless you happen to neglect it.

There is a certain discrepancy between curative and experimental observations about bloodletting in inflammation which the present state of science does not enable us wholly to reconcile. The blood in inflammation is found to contain more water than in the healthy state. Now bloodletting is also found, more than anything else, to increase the proportion of water—yet bloodletting is indubitably useful in inflammation. Perhaps the excess of water is due only to retained aqueous secretions, and is a pure addition to the blood, so that there is really a greater sum of fluid in the vessels; and by taking away this excess we are bringing the system nearer to a normal state, in spite of our unfortunately taking away red particles at the same time. Perhaps the good conferred by relieving congestion is so great as to counterbalance the evil of comparative anæmia. Perhaps the restoration of the intermediate circulation of water, by renewing secretion and absorption, is sufficient to weigh against the loss of red particles. Perhaps all or none of these suggestions are correct, but the fact remains indubitable, that venesection reduces inflammation.

The acute inflammatory state may be combined with other conditions of system, and may introduce its peculiarities into them. In the typhoid state especially this is often observed, which sometimes leads to and sometimes succeeds the inflammatory. With the catarrhal, too, this is sometimes the case, but more rarely, the imitation of it which then takes place not tending to lead to true inflammation. It is more common for periods of inflammation to occur in mucous fluxes, especially when at the first the system has not become habituated to them; and the continuous irritation of neighbouring local inflammation often, too, originates a flux, which may or may not perish when the cause is removed. Modifications are thus introduced into the treatment, and doubtful cases arise where the nicest judgment is required to decide which of two opposite courses should be adopted.

6. THE ANÆMIC STATE.—This condition is exhibited principally indeed in the bloodvessels, but it also is indicated by changes worthy of notice in the epithelium and papillæ. At an early stage the tongue becomes tumid, and has enlarged papillæ over its surface. The epithelium is thick, white, and soft, forming indents and furrows over the surface by its quantity; but it is easily washed away, and makes the saliva whitish and opaque. There is an unpleasant odour in the breath, probably from the large amount of effete epithelium. At a more advanced period, the tongue is cleaner and smoother, the epithelium is small in quantity, not having been formed in proportion as it has been shed. The prominent papillæ flatten down, and the surface is smooth. The breath is now pleasanter, and sometimes is almost like the sweet smell of a cow's mouth. The paleness and want of elasticity are however increased, indicated by the marks of the teeth along the rims and front of the organ.

So far as we can judge, pure anæmia seems to diminish secretion in the alimentary canal, both as to quantity and power.

Such would be inferred from the appearance of the tongue, and such is probably the case.

The conditions of system indicated by the tongue are such as are common in a greater or less degree to the whole alimentary tube at the same time. Purely localized derangements are not indicated by the organ in question. Thus cancer of the stomach, or even of the œsophagus, though so severe a disease and so near at hand, does not have its presence announced by the appearance of the tongue. Still less do localized ulcers of more distant viscera, unless there is some general affection of the whole mucous tract.

But yet parts in the immediate neighbourhood of the tongue do alter its appearance, and introduce some fallacies into our inductions, unless care be taken. Sore throat for instance, and diseases which especially affect the fauces, such as scarlatina, modify the look of the surface, so that it is not a fair index of the general state. So do decayed teeth. A proof of the latter is easily seen in the circumstance of one side being affected with a yellow coat, while the opposite one is free.

There are two reasons why the tongue should be more coated on the side where the teeth are decayed than in other places; first because the chemical decomposition of the particles of food in the vacant space keeps up an irritation of the adjoining part; and secondly, because if the teeth be tender they are less used for chewing on that side, and consequently the epithelium is not cleared away by the food in the usual course of mastication.

We must also take care not to set down as morbid certain strange tongues which we occasionally come across, and which are in fact congenital peculiarities. Such for instance are *deep transverse fissures*, which may be distinguished from morbid fissures by the lining of thin epithelium which is to be found in them—*large papillæ*, habitually kept clean and rubbed red by the friction which their size exposes them to—*an habitual fur*, which may be observed to differ from the fur of disease by its universality and equality—*a permanent coating* at the back, which is to be distinguished from the unhealthy coating by its gradual shading off into a normal surface (the yellow opaque epithelium of disease lies on an altered membrane, that of health on one of natural aspect; and where the diseased epithelium is rubbed off, the edge is sharp, while the healthy or habitually permanent one shades off gradually).

Accidental circumstances must also not be allowed to interfere with our judgment of tongues. In the notes which I have preserved of persons in robust condition and easy circumstances examined for insurance, there is every variety of tongue which we are in the habit of associating with chronic disease, and many of acute disease, produced in perfect health. Tobacco is guilty of a great many of these deceptions, producing in some persons who smoke it hot a fur, in others a white coat, and in some who spit a great deal an unnaturally clear aspect. I was once surprised to see even the orange-brown on a white ground of the typhoid state closely represented in a merchant who had never been ill, and found that such an appearance is not rare in those employed in tea tasting, an occupation in which he had been engaged all the morning

SECTION B.—*Changes in the Bloodvessels of the Alimentary Canal.*

A diminution in the power of the bloodvessels of the alimentary canal to absorb matters presented to them, is observed in several cases;

First, when the comparative density of the blood is lowered;
Secondly, when its motion is impeded;
Thirdly, when its alkalinity is lessened.

CASE I.

The increase of water in the blood in chlorosis is the simplest instance of the first; the patient is unable to absorb sufficient nutriment to supply muscular exertion out of the ordinary food, and unless a larger quantity of more nourishing aliments be taken, or destruction arrested by alcoholic drinks, she is exhausted and made worse by exercise. The more watery blood will not take in by endosmosis so much as it had been used to, and so tends to make itself more and more watery. If exhausting agencies are persisted in beyond what are warranted by the scanty supply, they contribute still further to aggravate matters.

We have frequent instances of this in the extraordinarily rapid progress of anæmia in young female servants. The girl perhaps is naturally slightly anæmic—she comes to service in London, where the absence of sunlight and of stimulating air deprive the blood still more of its globules—the place is perhaps no harder than she has been accustomed to, but the blood takes up less nutriment, and thus the physical exertion which formerly kept up the right balance of health now exhausts her and becomes *overwork*—in a month or six weeks she is completely laid up in a state of pallor and bloodlessness which it would take a year to bring a lady to.

The watery state of blood which we can see so clearly to exist in the universal body, extends of course also to the intestinal vessels; so that we can judge by the action of the digestive functions in these cases how they are likely to be affected by anæmia less openly conspicuous. We know well that in them the condition of the whole alimentary canal is that of extreme sluggishness, exhibited in various ways. The food remains unaltered for a considerable period in the stomach, and oppresses the sensations of the epigastrium with a heavy weight, not however amounting to actual pain, which commences about half an hour after meals. Localized pressure, as with one or two fingers, does indeed increase the discomfort, but firm support with the whole hand relieves it; as does also warmth, such as a hot sponge; thereby showing a difference from ulceration, congestion, inflammation, or organic lesions, which are made worse by all pressure and by heat. As the digestion continues there is apt to be palpitation of the heart; and sometimes the disturbance to the circulation is so great as to occasion fainting after meals, especially if the clothes are tight around the chest. If sleep comes on within three or four hour after a full meal there is nightmare, and the patient wakes up in excessive alarm from the quick beating of the heart. The muscular coat of the bowels is too weak to resist being distended with air, and the peristaltic motion is so slow that there is constipation to a marked degree.

We find in anæmia a great tendency to congestion after the state has lasted some time. The walls of the vessels appear weakened and less able to resist the pressure of the blood, in spite even of the diminished force of the latter. These congestions are local and variable. The place one can see them best is in the throat where in chlorotic cases the capillaries are often visible, injected with slow-travelling blood, and dilated. And in persons who die anæmic, the hypostatic congestion of the back part of the lungs and other viscera is familiar to all. We find the same in the stomach and other parts of the alimentary canal, and care must be taken, in the rare opportunities we have of studying the morbid anatomy of indigestion, not to confuse such a state with inflammation. We must be careful, too, not to mistake the effect of remedies. Local bloodletting, such as cupping or leeches, will often relieve immediately and for the time local congestion of the pleura, stitch in the side, and local congestion of the stomach in anæmic persons, simply by emptying the bloodvessels. Because bloodletting is an "antiphlogistic," we must not therefore set down the pain it eased as inflammatory.

The same slowness of all the functions of life is attested by *all* the excretions. The urine contains an extremely small quantity of urea or other solid matter; the fæces consist mainly of the undigested débris of food, and are very scanty. The perspiration and sebacious secretion are less than usual. The healthy moulting therefore of the tissues which opens the way for their renewal is arrested, and there is consequently but little new matter taken up by the alimentary canal.

The general distribution of the anæmic state throughout the body, renders the peculiar symptoms excited by it in each separate part less distinctive; yet we can hardly fail to distinguish in the above familiar description, which are due to the stomach, and which to the more advanced localities of the digestive tube; and we shall be able to recognize the state of anæmic atony where it occurs in the stomach or in the bowels alone, or in both together.

Remarks on Treatment.

It is interesting to watch how mere rest will often restore such a patient as above described; a few weeks' quiet in an hospital—less time often than it has taken to anæmiate—enabling the balance to be recovered.

I believe the rest to be of greater importance than the iron, or any other remedy which we give, being led to that opinion by the much greater rapidity of cure when the patients are in the wards than when out-patients.

In the same way an occasional glass of wine will arrest destruction for the time, and give the continuously diminished power of supply an opportunity for restoration.

A more complicated case is the anæmia of Bright's disease. Here it answers no good purpose to arrest destruction by rest and alcohol, for the poisonous agent, urea, is retained in the blood, and it is only by the metamorphoses of the tissues that it can be worked off.

Iron is in such cases of more importance than rest; indeed absolute rest seems injurious sometimes, and alcohol always; but the direct restoration of hæmatine to the blood by iron is *cæteris paribus* necessarily beneficial.

CASE II.

Diminished rapidity of the blood-stream as a cause of non-absorption, is exemplified in congestion of the whole or parts of the alimentary canal. This may arise either (A) *from irritative hyperæmia*, or (B) *from obstructive diseases of the heart or of the liver.*

(A.) The first state is very common as the result of excessive stimulating food or drink, acting principally on the first very sensitive part they come in contact with, viz., the stomach; so that this organ is rendered for the time incapable of absorbing liquids, and of course any solids which require to be rendered soluble therein. The food which is eaten, in spite of the inability to receive it, acts as a foreign body, and excites pain in the nerves of the part, unusual reflex actions, and perhaps even inflammation. At all events it keeps up the congestion which renders it a foreign body; for it is natural for blood to flow towards the stomach when food is there, and the longer its flow is continued the greater grows the congestion and the inability to form the natural secretions. This is the *acute* form of hyperæmia. Dr. Beaumont had an opportunity of seeing with the naked eye this lesion in action on his well-known patient with a fistulous opening in the side. He describes the mucous membrane of the stomach after a debauch as red, raw, and smooth in patches, neither secreting gastric juice nor taking up the victuals. These latter lie like a load in the stomach, and by their further fermentation much increase the irritation.

Remarks on Treatment of Irritative Hyperœmia.

The cure of this temporary condition produced by (we will hope) temporary causes lies obviously in abstinence, and in allowing the vessels of the stomach time to recover and empty themselves.

It seems at first sight inconsistent with the rational mode of relief by abstinence to find practically that stimulants will also give relief, not only to the nervous depression which follows excess, but also to the gastric symptoms. "A hair of the dog that bit him," is as comforting to the stomach of a debauchee as it is steadying to his trembling hand. The explanation probably is, these agents deaden the morbid sensibility of the nerves of the part, and perhaps resuscitate the motion of the peristaltic muscles. They postpone the concentration of the whole of the natural reaction of the system on the period immediately following that which originated it; they dilute the punishment for the offence over many hours, instead of letting it be endured during a few in its full intensity. This doubtless is a relief to a weak-minded man, who is intolerant of the consequences of his indulgence; but it is probable that the whole evil effects are in the end greater when thus spun out than when they take a natural course.

This irritative hyperæmia may often be seen extending up to the throat, making that part red and relaxed. It swells up the papillæ of the tongue, and produces an unnatural adhesiveness of the epithelium, and a disagreeable sensation in the nerves of taste. This is the case very often without the sensibility of the epigastrium being affected.

A chronic state closely analogous to this acute one is produced sometimes in weakly persons by the incautious use of stimulants, either in the shape of medicines or drams, to assist their naturally sluggish digestive canal, and by their not allowing it that rest which it demands at their hands. The congested bloodvessels have no time to empty themselves before they are again called into action, and bid to work double tides by a hot stimulant. Hence they become permanently dilated, and may be seen spread in a red varicose network over the back part of the throat, tonsils, and uvula. This state is further aggravated by the sluggishness consequent on the languor of debility and oppressed digestion, which retards the circulation, and of course increases the congestion.

Many patients too often co-operate with their enemy by misplaced "coddling." Changes of temperature are most beneficial by encouraging circulation; and the guards against variations from heat to cold which these people adopt, either from false theory or invalid chilliness, are almost always injurious.

In these cases it is very often the state of the throat which is most complained of. The unfortunate part is causticed, and gargled, and steamed; the tonsils are excised, and the uvula cut off; tonics and stimulants are taken to an unlimited amount, but with only temporary and partial, if any relief; and the more respirators and handkerchiefs are worn, the more frequently does the sufferer "take cold." If however he is a person of strong determination, and has good advice, let him not despair of cure: a course of low diet, consisting principally of biscuit, cold water, beef tea, and lean meat, a complete abandonment of all wrappers and comforters, with abundant exercise in cold fresh air, and *an avoidance of all local measures* whatever, will restore health to him in six or eight weeks, and prevent a recurrence of the complaint.

Delicacy of appearance should not prevent recourse being had to this hardening process: for in fact most of the individuals who become affected in the above-described manner, exhibit such an aspect. They are often reported by non-medical friends as consumptive; and indeed without a careful examination of the chest it is unwise to pronounce they are not so, as their countenance and manner bear a close resemblance to the phthisical, and the tickling cough excited by the relaxed uvula is very like that which arises from tubercular lungs. When however the chest has been found healthy, no timid counsels derived from less positive information should prevent the adoption of the decided measures above recommended.

(B).—*Lesions which obstruct the circulation* do not invariably produce defective digestion; but where they do so, it is most exhibited by the difficulty experienced in absorbing liquids. Hence in persons whose portal circulation is sluggish from disease either of heart or liver, or simple general debility, there is often a continuous distressing "*glug-glug*" in the stomach and intestines, from the quantity of liquid matter in them churned about with the air. Sometimes this excess of liquid causes diarrhœa: more often it exists only in the stomach and ilia, and is absorbed in the colon.

Remarks on Treatment of Obstructed Circulation.

To such persons slops of all kinds produce much more inconvenience than solid food; so that a state of things exactly the reverse of the normal is produced, and aliments are digestible in an inverse ratio to their dilution.

Medicines also, in persons who have a circulation defective in this way, often produce no effects, from not being absorbed during congestion of the abdominal viscera, which, on that congestion being removed, are very active in much smaller doses. Sometimes they will lie dormant in the intestinal canal till the impediment to their absorption be taken away, and then act with great energy. I once gave a patient two grains and a half of elaterium without any evacuation following it; but on some leeches being applied to the anus, without any fresh medicine being administered, the previously given dose acted most powerfully as a hydragogue cathartic. It must have laid *perdue* in the intestines till the opportunity for its absorption arose.

CASE III.

The *alkalinity* of the blood has not been comparatively observed enough for us to say in what diseases it is diminished, or if it is increased in any; but the physiological experiments detailed in Book I. (pages 24, 25) give reason for believing that in perfect health it is at its maximum, and that in that state it is a powerful aid to absorption; for it was shown that the phenomena of osmosis exhibit always a greater current from an acid into an alkaline fluid than *vise versâ*, and that the strength of the current is in proportion to the alkalinity of the attacking fluid. Hence we may conclude, that whenever observation does teach us in what conditions the blood is deficient in alkali, they will be found to coincide with defective absorption and assimilation.

SECTION C.—*Changes in the Mucus of the Alimentary Canal.*

The chronic increase of mucus has already been mentioned as a morbid state, associated with changes in the epithelium, and faintly indicated by the tongue. When increased in quantity it is also altered in quality, becoming much more tough and adhesive than natural. It is probable that in perfect health only just enough is formed to keep the membrane pliant and soft, and that a microscopic quantity only should be carried along with the excretions. When therefore it is abundant, it is a foreign body, and acts according to its physical qualities as such: it envelopes the food, and impedes the gastric juice from freely mixing with it in the stomach; it gets in the way of its contact with the absorbent veins and lymphatics; and in the ilia and in the colon by its slipperiness and elasticity prevents the muscles of the gut from duly urging forwards the fæcal mass. Hence we have the food fermenting in the stomach, and generating fœtid gases and morbid acids, relieving pain, indeed, for a certain period after it is swallowed, but by the above-mentioned chemical decay producing infinite distress in the later periods of digestion, failing to afford nutriment in the intestines, and causing alternate constipation, colic, diarrhœa, &c., when it gets lower down, making the fæces lumpy, slimy, and hard.

The above-mentioned evils are probably aggravated by the naturally alkaline state of the mucus; it must neutralise the acid gastric juice as poured out from the membrane, at the same time that it is indirectly causing the generation of acetic and other acids of decomposition in the interior of the alimentary mass; so that we have decay instead of digestion: and it must make the contents of the intestines more alkaline instead of less alkaline than the blood, and so obstruct osmosis.*

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* See pp. 20, 21, in Book I.

But such physical agencies do not operate equally on all forms of aliment. The albuminoid matters must be most affected, as was shown in the dogs operated upon by Drs. Bidder and Schmidt, where, if digestion of albumen was prevented by arresting the gastric juice, fœtid decay took place.* Sulphuretted hydrogen is consequently produced in the intestines in excess, and great depression of vital energy arises, with great discomfort—in fact, partial poisoning by that deleterious agent.

Of other articles of diet, fat would be little impeded in its absorption, indeed it would be perhaps rather assisted by saponification in the alkaline mucus. We find, consequently, that the subjects of gastric mucous flux, though they show by their paleness and anæmia very often the want of proper nitrogenous food, are generally not emaciated; the adipose tissue is well supplied, nay sometimes they are troubled with inconvenient obesity. But though it appears to be absorbed, yet fat in excess causes distress by becoming rancid when it is so long delayed in the alimentary canal, and often when in lumps becomes enveloped in mucus, and remaining undissolved is passed in this state from the bowels.

Starchy and saccharine foods in moderation can be digested, if allowed to take their time, and do not cause so much inconvenience by their decomposition; but unfortunately they require to be eaten in such quantities, to supply sufficient nutriment, that their mere bulk is an objection to their use. If too, they are mixed with albuminoid substances, they are apt to have fermentation set up sooner than they otherwise would, and so to add very much to the amount of chemical decay.

The alimentary mass lying long undiminished in the stomach, instead of having its external parts continuously softened and wiped away by the peristaltic wave,† is an unnatural weight for the organ to bear, and it rebels: reflex action is often caused, and the burden rejected by vomiting. If much mucus is thrown up, and soon after a meal, the rejecta are often alkaline; but if they have delayed long, fermentation has often taken place, and the teeth are edged, and the room filled with an intense smell of acetic acid. Sometimes the vomited matters are sour, but still with lumps of alkaline mucus floating in them.

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* See pp. 93, 94 in Book I.

† See p. 48.

Sometimes the mucus is so sticky and tough that it cannot be ejected by ordinary vomiting, and then we have thrown up only acid fermented food; and the peristaltic motion of the canal is incapable also of carrying it forwards: so that it is very apt to remain fixed in various parts of the stomach and bowels, and then often affords a home to a variety of living germs, animal and vegetable. The curious mould, recently named "*sarcina ventriculi*," takes up its abode in the stomach, propagates on the surface of the mucus,* and fills the fermenting contents of the organ with its quickly growing germs; or the solitary "*round worm*" is enabled to retain a position, and maintain itself on the ingested food.

In the same mucus in the intestines also appear worms of several sorts. These parasites are not in themselves a disease, but at first the products of disease, and secondarily sometimes the cause of further phenomena. The excretions even of the most healthy persons frequently contain them, without any inconvenience having been produced. It is only when, from the amount of tough mucus, they have been enabled to retain their position long enough to arrive at maturity, and leave their eggs behind them, and to convert the dead smooth slime into an irritating mass of life, that they are of any consequence.

All questions connected with parasites are so dependent on the part in which they are generated, that they would require to be repeated if any generalities were here introduced, and they had better be deferred to a future page.

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* It is not often that an opportunity occurs of seeing a case of gastric catarrh after death, but one such we had at St. Mary's Hospital, last year. A girl of thirteen died under my care with enlarged heart, having previously suffered with the symptoms above detailed. She vomited frequently, and no *sarcinæ* were to be found during life. In the stomach after death they were seen in abundance, *adhering strongly to the surface of a thick layer of stringy mucus*. The stomach was otherwise healthy, gastric glands and all.

SECTION D.—*Changes in the Water circulating through the Mucous Membrane.*

The great importance and the extent of the intermediate circulation of water through the mucous membrane of the alimentary tube has been largely insisted upon in the First Book (Chap. II., Part I., Section D). Alterations, then, in its quantity may be inferred to be of considerable consequence.

In the typhoid or febrile adynamic state we find secretion diminished at the same time with absorption. In some places it is diminished in a greater degree than absorption; so that, evaporation being superadded, a dryness of membrane ensues (page 238): such is the case in the mouth. But where evaporation does not take place, as in the ilia, a serous transudation is found, which surpasses the ability of the debilitated absorption to remove, and so diarrhœa ensues. A general idea of the aqueous circulation in the typhoid state would represent it as diminished or obstructed in both directions, both going in and coming out of the membrane, but that its place in the outward course is partly occupied by a morbid serous transudation from the bloodvessels, which not being reabsorbed, constitutes the diarrhœa so characteristic of this state.

It is obvious that under these circumstances digestion must be very much impeded, even in the case of those victuals or drugs which can be immediately received by osmosis into the veins; but that in the case of albuminous and other substances, which require modification by peculiar secretions, it is all but annulled.

The administration of diluents by the mouth supplies in some degree, though of course in an imperfect manner, the deficiency. It is water that you offer to the stomach and intestines, as a possible means of carrying in some nutriment to the system; but it is not saliva, gastric juice, or bile, with their peculiar solvent powers.

The state of things in congestion, or obstructed circulation, is different. Here secretion is but little affected, and in consequence there is plenty of water poured out; but its reception back again is interfered with by the sluggish bloodvessels. Diluents therefore cause distress, especially in the upper portions of the intestinal canal, where the congestion is usually most predominant.

In pure anæmia the aqueous circulation does not appear to be interfered with. The secretions are abundant in respect of this great constituent; but yet they are deficient in the solvent properties they ought to possess: at all events, they seem to act as solvents with diminished energy. Watery drinks are not therefore to be commended, unless it should appear that the quantity of secretion is deficient in the alimentary canal in quantity as well as in quality. The best test of the latter proposition is the examination of the belly: should there be frequent "glugging" noises on motion, or gurgling perceived on pressure, or a continuous churning as of soap-suds heard with the stethoscope, there is an excess of unabsorbed water rather than a deficiency, and an addition to it is unadvisable. Should these signs be absent, diluents may be likely to agree.

The examination of the stools does not give sufficiently accurate information concerning the quantity of water lying loose in the intestines; often, when there is positive evidence of an excess, the fæces are rare, hard and concentrated. The fact is, that during their retention in the colon absorption goes on continuously; and thus their concentration is very much dependent on the length of time they have been in the lower bowel. An experimental proof of this may be obtained by taking a saline purgative, and resisting, by strong voluntary efforts, the inclination to void the results. In a short time the inclination goes off, again to return when a further collection of fluid has come down. If it is resisted continuously till the flow of liquid matters from the upper parts has ceased, no diarrhœic stools at all result, the whole being concentrated down, by absorption, to the ordinary consistency. If then there is a morbid contractility of the sphincter ani and rectum, as is very commonly the case in the anæmia of the female sex, the stools may be hard, though the bowels are overstocked with free liquid.

In catarrhs the increase of secretion causes the outgoing of a quantity of water greater than ordinary; and, at the same time this is mixed with so much adhesive mucus that it cannot be freely reabsorbed. Diluents are therefore required to supply the deficiency which arises in the circulation.

Where there is a retention in the system of some solid result of decomposition of the tissues, which ought to be discharged—as for example, in Bright's disease or uræmia, cachexia, plethora, jaundice, rheumatism, gout—it should be our endeavour to make the outgoing current exceed the ingoing as much as possible, in order that it may carry out with it the retained matters. Where a gaseous matter is retained in the system, as carbonic acid in asphyxia and cyanosis (which I name as types of the acute and chronic retention), it may be doubtful how far the watery excretions help to relieve, for the main obstruction is in the gaseous department of the lungs. Moreover, it has before been pointed out that, in the chronic examples at least of this state, as in cyanosis from diseased heart, there is a difficulty in the absorption of liquids, which throws any excess loose upon the intestines, to their great inconvenience.

The amount of water taken in and given out of the body, that is the general circulation of fluid in which the body forms part of the whole system of nature,* was shown in the First Book, to determine the amount of moulting or metamorphosis of the tissues; and upon the amount of metamorphosis if there is a full supply of new matarial, depends the perfection of life.† In a healthy body, then it cannot be imagined that the amount of water and of metamorphosis could be excessive.

But there are imperfect states in which a proper supply of new material cannot be furnished, such as mechanical impediments to nutrition; and others where the discharge of material is already equal to any supply that can be afforded, as phthisis, suppuration, diabetes, colliquative diarrhœa. In these it is desirable to limit the amount of water passing through the body, to make it less than natural, in order to be in harmony with already existing unnatural conditions.

Résumé of Remarks on Treatment.

To resume the practical deductions: aqueous food and drink in abundance is beneficial in the typhoid adynamic state; in anæmia where the portal circulation is free and water easily absorbed; in catarrhs, and in diseases where the products of destructive metamorphosis are retained, such as Bright's disease, rheumatism, gout, jaundice. It is injurious in obstructive diseases of the portal circulation, such as lesions of the heart and liver; in anæmia where there is an impediment to the free absorption of water; and in morbid states where the destructive metamorphosis not actually in excess compared with its healthy amount (nay, even perhaps deficient), is yet in excess when the condition of the other functions of the body is taken into consideration; as for instance in phthisis, suppuration, &c., where the outgoing is already too great, and in mechanical impediments to nutrition, where the supply cannot be sufficient.

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* See p. 37.

† See p. 184.

SETTION E.—*Morbid Affections of the Digestion traceable to Nervous Influence.*

For mental emotions to exhibit great power over various parts of the digestive canal is not morbid, but strictly physiological. Nobody asks to be cured of losing his appetite when he hears of the death of a dear friend; of being nauseated when he stumbles suddenly on a capital execution; or of missing his daily evacuation during an anxious canvass for a public appointment. Sometimes the excess of sensitiveness amounts to a very inconvenient idiosyncrasy, and never more so than when agreeable emotions which we do not like missing produce uncomfortable results. An occasional patient of mine, of good constitution, passionately fond of dancing, tells me that on first "coming out" she never went to a ball without being obliged to retire several times early in the evening to vomit. The symptoms were quite independent of dancing or not dancing, or of the contents of the stomach, except that they were accompanied by more straining when it was empty. I do not however suppose that there is any way of escaping such inconvenient peculiarities, besides the avoidance of the circumstances which call them into play.

More protracted psychical agencies produce more chronic morbid conditions. The common character of anxiety includes the majority of these mental causes. Ambition, household cares, commercial speculation, deferred hope, secret love, and so on, act in a similar way. But there are others where violent tension of the mind alone allies them to the above named feeling. Such for example is excessive intellectual exertion for its own sake, deep thought on abstract dogmas of theology, on pure science, &c. Something between the two are the laborious strainings of second-rate literati writing against time, than which nothing is more exhaustive to the powers. There are perhaps no beings in the universe who suffer so much from indigestion, as unhappy periodical writers forced to spin their brain-web over a given space by a given hour—*aranearum more ex se fila gignunt*—and are scarce able to derive nutriment from the bread they get, having used up their capital of nervous power in getting it.

The deficiency of the natural distractions of the mind by the varying objects around is a fertile source of derangement of digestion. The most obstinate cases of dyspepsia I ever saw were two blind dispensary patients, whose whole thoughts, withdrawn from outward things, seemed concentrated in their abdominal viscera. Physical blindness and complete abstraction of thought are not very different from one another in their nature and effects.

All forms of derangement of digestion are capable of owing their origin to mental agencies; but I have observed in them, when derived from this source, one common peculiarity—namely, that the nervous susceptibility of the parts affected is beyond all proportion to the visible phenomena: the pair is much greater than the lesion of function. *Excessive* weight at the epigastrium and distension is felt after a meal, but the abdomen is not fuller than natural, nor does digestion seem much longer about than in ordinary individuals. Or there is great heartburn, but no acorous eructations or water-brash. Sometimes uncomfortable sensations are experienced during the whole of digestion; and patients will insist upon it that they can feel with their bowels the food and medicine undergoing all the natural changes thoughout their passage. This latter anatomical accuracy, however, I believe, to be a flight of imagination; for I never heard of it except in educated persons who had read books of physiology, and its full development is to be found in medical men. Hospital patients never feel a meal grinding round the circle of their stomach, oozing through the pylorus, or passing the ilio-cæcal valve; nor do they describe the melting of pills, the absorption of draughts, &c., nor undergo the thousand and one miseries so graphically delineated as experienced in his own person by Dr. Barras.* Nevertheless they do feel pains as long and severe, but said be situated more vaguely in the belly at large.

Though capable of being associated with and perhaps leading to other disorders of the digestive organs, this morbid sensibility frequently exists alone. The peculiarity of such cases is that instead of the action of the canal being torpid, the passage of the victuals slow, and the bowels constipated (as they are apt to be in most derangements except the inflammatory), here where the sensibility is alone augmented, an increased rapidity is exhibited; the stomach is soon emptied, and the alimentary mass arrives too early at the colon, whence there is an immediate tendency to expel it in a semi-liquid state, constituting a sort of diarrhœa. It is, however, usually not difficult to resist this tendency, and to keep the fæcal matters till they have become more solid. Resistance to the tendeucy seems not only to retain the contents of the colon, but to prevent the bowels from emptying themselves too soon; for on the stools being passed the next day, there is no excess of undigested matters in them; whereas if the inclination is yielded to, the food is found almost in the same condition as when eaten.

Occurring alone, exalted sensibility of the digestive canal will almost always be found to have originated in mental causes. But it may be associated with, or superadded to anæmia, atony, or deficient muscular action; sometimes also to mucous flux and to water-brash; and then it may arise, as they do, from purely bodily sources. These are such as will hereafter be discussed as the causes of the aforesaid maladies in several situations.

It not unfrequently alternates with neuralgic pains of other parts, hysterical affections, brow ague, tooth-ache, tic-douloureux; and sometimes seems to owe its origin to pain from organic structural causes, such as disease of the bladder, stone, stricture, dysmenorrhœa, chronic gout. But I question whether in these latter instances the mental anxiety may not be in a chief measure the agent in the production of the nervous complaint of the intestinal canal, as it does not come on without the patients are reduced to a weak anæmic condition.

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* *Traité sur les Gastralgies.*

SECTION F.—*Morbid Affections of the Muscular Coat of the Alimentary Canal.*

There can be no general remarks on the derangements of the voluntary and semi-voluntary muscles which govern the entrances and exits of the digestive tube, because they are so different in different parts. What is to be said will be reserved for the several localities where their duties are exercised.

The peristaltic motion of the muscular coat is liable to the following disturbances:—

I. It may be too weak for its work.

II. It may be arrested for a short distance by an organic change in the walls of the tube.

III. It may be completely stopped by mental emotion.

Debility of the muscles may be a consequence of anæmia, the watery blood not sufficiently stimulating the fibrous tissue to contraction. In general anæmia we always find the stomach, small intestines, and colon sluggish and unequal to carry on any but very light duties. And the same happens in many cases of indigestion where there is not indeed general anæmia, but such a want of tone in the alimentary canal as justifies the assumption of a similar local condition. Such a state of things is a very usual accompaniment of other lesions of the mucous membrane, of acute catarrh, of chronic mucous flux, of mechanical congestion in visceral degeneration, &c. The most effectual means of relief are certainly not active purgatives. They indeed empty out by a violent effort the whole canal, but a reaction of constipation follows the weariness of nerve and muscle induced by this effort. What we want is a better stimulant for the muscles and nerves, and we can give that permanently only by increasing the vitality of the blood in the abdominal vessels, that is to say, getting rid of the old effete blood, and forming new blood quicker. The first object is accomplished by medicines capable of augmenting gradually and permanently the metamorphosed matter moulted by the stools; which we find in aloes combined with small alternate doses of mercury. The formation of new blood is promoted by iron better than anything else. When the cure has once commenced, then sulphuric acid, bark, gentian, and other bitters increase the appetite and the power of digesting food, but I do not find them answer so well at the beginning of the treatment as aloetic pills, with half a grain or a grain of grey powder, given each night, to act quietly on the whole system during the hours of repose, and a teaspoonful of steel wine after every meal.

Debility of the muscles may be relative, not absolute. That is to say, the work given them to do may be excessive. This is the case when the stomach is over-distended; the circular fibres act at a disadvantage, just as in paralysis of the bladder from retention of urine. In a healthy person nature relieves herself by vomiting, but in the weakly person serious injury may be done by overloading the stomach. And it must be remembered that in atonic dyspepsia a comparative state of debility exists; the organ cannot bear a meal which would be nothing extraordinary to a robust man; and consequently food must be taken in smaller quantities and at shorter intervals than in health.

Is the peristaltic wave ever too strong for its work as well as too weak? That is to say in fact, is diarrhœa, or the too rapid passage of the contents of the alimentary canal, to be referred to excess of action? I confess when I see this action most commonly produced by ulceration, inflammation, and other causes which generally arrest muscular motion, I am loath to suppose that the peristaltic wave is increased in power under such circumstances. I believe a more powerful motive cause in diarrhœa to be a deficiency of absorption, and a consequen proportionate excess of fluid secretion, which the force of gravity and a peristaltic wave of an irregular weak character allows to proceed over fast. All evidence seems against the supposition that the bowels are in a state of tonic contraction.[*]

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[*] The question of *anti*-peristaltic movements ought perhaps here to be allude to, but to prevent repetition, and for convenience, it is delayed to a later part o the volume, and will be found in Chapter IV. Part II. § I. of this Book.

SECTION G.—*Changes in the Media of Solution, and General Remarks.*

The principal common property possessed by the media for the solution of substances submitted to the alimentary canal, is their containing a large quantity of water. The alterations in that have however been spoken of a few pages back, and will again be alluded to in special departments.

It is a proof of the close connexion between physiology and pathology, to observe that both are equally dark and deficient on the same points. Comments have been made in the First Book on the varying and untrustworthy statements made by chemists concerning the healthy condition of these juices now under discussion: just the same obscurity broods over the variations they must of course exhibit in disease. It may be noticed in the succeeding pages, that our knowledge of these deviations from the normal condition is nearly limited to excess or defect in their quantity, that is to say, to their aqueous contents.

The general indications of the deficiencies in the working order of the alimentary mucous membrane sketched out in the preceding pages, may occur coincidentally with all kinds of anatomical lesions of the membrane itself, of the glands supplementary to it, or of distinct distant organs. They give hints how the diseases arising out of a compound of the phenomena of the local disorganizations with the general condition may be alleviated, and are therefore of value as introducing modifications of treatment. It is true our choice of treatment must not be based on them alone; and sometimes the specially affected organ is of such importance that the general symptoms must be neglected for a time. But still they must never entirely be lost sight of.

It must be remembered that it is through the digestive canal that we aim by our drugs at curing these local lesions; and that to take no notice of its state is to be careless about the gates through which we hope to enter the enemy's stronghold.

I would urge, therefore, attention to these indications as the chief guide to rational treatment in diseases, not only of the alimentary canal, but of all other parts whatsoever, believing it to be the main element of success in our endeavours to modify by artificial means the course of morbid processes.

I am the more anxious to print these last few sentences, because, from the habit of studying pathology principally in the dead body, and naming as diseases only those phenomena which are capable of being put up in a museum, men come to consider the permanently altered, perhaps incurably altered part as the chief thing to be thought about in treatment. They aim their drugs at the lungs in pulmonary consumption, at the kidneys in Bright's disease, and are then surprised at most discordant effects following the same medicine in two consecutive instances: not recognising that the state of the alimentary canal and its functions was different in the two, and hence that different, perhaps opposite, results followed their treatment. Yet, as it is the alimentary canal alone which can supply the nutriment or medicines to the lungs or kidneys, and through whose original vagaries in supplying nutriment or medicines the lungs or kidneys have in two-thirds of the cases become diseased, to pass it over would seem to an unprejudiced mind a most irrational proceeding.

CHAPTER III.

ON MORBID STATES OF THE MOUTH AND GULLET WHICH AFFECT DIGESTION.

THE value of observations on the appearance of the tongue and fauces, as indications of the condition of the rest of the digestive membrane, has been already amply pointed out, but it cannot be said that these parts have any important influence themselves over the future absorption of the food. In sore throats truly the appetite is lost, there is nausea and vomiting, and in other ways nutrition is shown to be affected; but there is reason to believe that these symptoms arise from the stomach being in a condition analogous to that of the throat. Indeed the unhealthy contents of the matters vomited and of the stools sufficiently indicate that fact.

The principal deficiencies in the mouth and œsophagus which affect digestion are, first, *mechanical impediments*; secondly, *defects in the secretion of saliva*; and thirdly, the obscure condition called *heartburn.*

I.—*Mechanical.*

Chewing.—The deficient chewing of the food injures digestion, partly by not sufficiently dividing it so as to enable each portion to arrive at the digestive membrane, and partly by not saturating it with the saliva. Albuminoid substances suffer principally from want of division, starches from non-saturation with saliva as well. For so that the former are capable of being completely penetrated by the gastric fluid, their admixture with the secretions of the mouth is of small importance; while the latter, if not converted into sugar by the saliva, have to wait till they meet the pancreatic juice for that first condition of solution. It may be observed, that carnivorous animals bolt their food in large lumps, without apparently suffering inconvenience; while vegetable feeders prepare it for the stomach by a long course of mastication, and in some cases by *re*-mastication after soaking in the first receptacle.

Hence it is much easier to supply the place of chewing by mechanical preparation in animal food than in vegetable. We can grind things small, but we cannot make an artificial saliva. Kitchen science may prepare the former for the stomach, but not the latter. Indeed, the cooking of starchy foods for weak stomachs often makes them more indigestible, by reducing them from a solid to a fluid form, and thus enabling them to be swallowed without that manipulation in the mouth which elicits a flow of its secretions. The best form in which starch can be taken is one in which the envelope of the granule has been ruptured by heat, and the whole mass made light so as to be capable *by* mastication, of being broken up and fermented equally by fluids, but not capable of skipping over the salivary admixture, and being swallowed *without* mastication. Such are good stale bread, mealy, well-boiled potatoes, thoroughly cooked cabbages: such are *not* new rolls, waxy potatoes, &c., which mastication merely makes into small, solid, tough lumps; or gruel, sago, and other slops, which annoy the dyspeptic, though so often forced upon him by his female friends.

Defective mastication, as a cause of bad digestion, arises most commonly from teeth being absolutely wanting. This may be ascertained by a review of the mouth. Sometimes it is from tenderness, without absolute deficiency or rottenness; and the tenderness is sometimes so slight as not especially to have aroused the attention of the patient: so that it is not mentioned, or even perhaps denied. The best guide to our suspicions of this state of things is to observe that one side of the tongue or throat retains its opaque epithelium—is "coated;" while the other is scraped clean: the coated side is the one where the mastication is imperfect. Mechanical rectification by a dentist is of course the treatment indicated.

Swallowing.—The action of the throat in swallowing is interfered with by disorders which cause pain, as well as by those which offer a mechanical impediment to the muscles—by superficial ulceration, congestion, catarrh, &c.—as well as by deep ulceration and cancer. The interference, however, has no im fluence over the subsequent process of digestion, and is a very small part of the diseases in which it is manifested—"*pars est minima ipsa sui*"—so further notice about it is not required.

The gullet is less sensitive, and only such lesions as actually prevent the free motion of the muscles cause difficulty in the later period of swallowing. Superficial ulceration of the œsophagus I have seen several times in the dead body, without any symptoms having arisen from it during life; and doubtless we should find it oftener if we were more in the habit of examining that part.

Structural diseases of the œsophagus are often accompanied by vomiting. This is sometimes vaguely attributed to "irritation;" and when it occurs the parts are said to be "irritable," and when it is absent they are "not irritable." The fact is, it arises from the paralysis of the muscular parts, in consequence of their partial destruction, and its presence or absence is dependent on the position and extent of the part affected. By referring back to the experiments on dogs of Drs. Bidder and Schmidt, detailed in the First Book, it will be seen that division of the pneumogastric nerve caused paralysis of the gullet and constant vomiting, the stomach remaining unmoved.* In fact, it appears that where the natural propulsive motion of the œsophagus is wanting, and the matter swallowed cannot proceed in a continuous course, their detention causes the muscles accessory to vomiting to act, and the mass is thrown upwards. Hence we have vomiting in cases where the tube is simply deficient in muscular power, as in central cerebral lesions; in dilitation, or hernia of the tube; sometimes even in simple local weakness or general faintness. The practical inference is, that where there is difficulty of swallowing and vomiting, it is no proof positive that organic lesion of the œsophagus exists.

Generally the ejected matters consist simply of the food which has not passed through the cardia; but sometimes the reversed efforts draw up some of the contents of the stomach, and then they may be acid, and the observer may be led to infer that there is gastric disease, which diagnosis turns out afterwards to be incorrect. A more careful scrutiny will prevent this error, for it will rarely occur that the vomiting from œsophageal lesion is acid on every occasion, and the absence of acidity only once should lead to suspicion of the matters not coming from the stomach.

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* See pp. 40, 41.

Remarks on Treatment.

When structural injury, whether simple ulceration or malignant destruction of the œsophagus has got to the point of producing symptoms, it has advanced too far for any cure to be possible. Yet careful observation of such cases may often enable us to be of great use in alleviating pain and prolonging life. We may arrange diet and medicine in a way to render it possible to take food enough to support nature and to make existence bearable.

From its toughness and capability for rough work during health, one would not have guessed how fanciful the œsophagus is in disease. Its morbid idiosyncrasies surprise us; it rejects by vomiting one food, and accepts without repugnance another, which in health would have gone down with exactly the same ease or want of ease. I have observed, though I cannot in any way explain the fact, that substances acceptable to the weak stomach, especially to an ulcerated surface of it, are often carried down with facility by the sore œsophagus; whilst those which the dyspeptic knows well disagree, are equally obnoxious to the injured gullet. The addition of lime-water to milk makes it easier to swallow, just as it makes it easier to bear in the stomach; cocoa passes with more facility than tea; oil, in spite of the mechanical lubrication of its consistence, is rebelled against; whilst the same medicines which still pain in the epigastrium, and enable the gastric motions to go on, such as prussic acid, alkalies, and particularly trisnitrate of bismuth, blunt also the oversensibility of the œsophagus, and make it capable of performing its duties.* I would call the attention

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° I was particularly struck with this in a case of simple ulcer of the œsophagus under my care, which afterwards proved fatal by peforating the pericardium: by taking first a dose of trisnitrate of bismuth, the poor girl was enabled to swallow food at a stage of the disease when deglutition was impossible otherwise.

of all who have to treat œsophageal lesions to these facts, for the judicious observance of them will often enable great alleviation to be brought to the heartrending distress of the poor patient.

Where simple paralysis occurs without a sore surface, or where the obstruction consists of a pouch formed by an hernial state of the tube, the chemical nature of the victuals seems to make no difference, but their mechanical structure is of some importance: small quantities of fluids, taken in sips, seem to trickle down, lubricate the passage, and assist the swallowing; while large draughts must be avoided, for they get into the pouch, or distend the paralysed tube, and cause vomiting quite as much as a solid meal.

II.—*Morbid States of Salivary Secretion.*

Saliva is poured out from so many parts, that serious injury would not be likely to happen even if one source was quite impeded. Besides which, the glands which furnish it possess a great power of accomodating themselves to considerable change of circumstances, so that many of those addicted to the nauseous habit of spitting do not seem to suffer from it. Others, however, less robust do suffer, and I feel no doubt that the loss of saliva has something to do with their ailments. Dr. Frerichs, in his experiments on saliva made on his own person, experienced an oppression in the epigastrium, and loss of appetite; and Dr. Wright in secreting 250 grammes of saliva in a week, lost eleven pounds in weight.* It seems however that in the case of tobacco-smoking this loss is a less evil than the ingestion of the narcotic juice, for those who spit are less dyspeptic than those who do not.

In the typhous adynamic condition the deficiency of saliva is shown by the parched lips and mucous membrane, the cracked brown tongue, and the thick sordes which there is no natural secretion to wash away. The deficiency gives us a warning not to trust for nutriment to starchy food during this state of things; it cannot be converted into a soluble substance, and therefore passes through the bowels unabsorbed. Whether gruel, arrow-

* *Lancet*, 1843.

root, sago, &c., are of use in shielding the mucous membrane from acrid juices, by taking the place of the mucus with their slimy texture is another point: I am inclined to think they are of some advantage in the upper parts of the alimentary canal; but supporters of life they cannot be considered. The most valuable part of their contents is the water they are boiled in, and the wine, sugar, and spices with which good housewives flavour them. The question we have to ask ourselves in discussing the propriety of starchy foods in individual cases of low fever is, whether we wish or not to have some slimy unabsorbable matter in the stomach, and whether time can be afforded for supplying the patient with a food of inferior use to him. It must be remembered that the constant feeding without appetite is a serious distress to the sick person, and where great disinclination to swallow anything exists, it is of importance not to waste time and opportunities in giving the less useful food, for fear the absolutely necessary should be refused. In all such cases the state of the mouth and the salivary secretion is a good guide to the practitioner in the choice of diet.

III.—*Heartburn and Water-brash.*

"Heartburn" consists of a painful sensation of heat running up in paroxysms from the pit of the stomach to the fauces. When the same sensation is accompanied by the ejection of a watery fluid, it is called "*pyrosis*," or "water-brash."

There is every reason to believe that the last-named liquid does not come, as used to be represented, from the stomach, but from the glands at the bottom of the œsophagus. For in the first place, when thrown up without much effort, it is alkaline; and only when there is sufficient heaving to eject some of the contents of the stomach, does it present an acid reaction. Secondly, it exhibits in the microscope the same appearance as saliva, containing the scales of pavement epithelium which line the mouth and œsophagus. It possesses, too, the power of turning starch into sugar, and gives evidence of the presence of sulphocyanide of potassium by its reddening action on the protosalts of iron.* Now the resemblance of the œsophageal cardiac glands to the salivary glands is stated to be very close,* while the gastric glands are quite different; and as it may reasonably be assumed from analogy more likely that similar glands form similar secretions, than that diverse glands form similar secretions, the attribution of the fluid in question to the lower part of the gullet is an obvious conclusion.

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* Lehmann, *Phys. Chemie*, ii., 181. "Erbrochenes."

The probable *rationale* of its collection in the considerable amount which is thrown up in attacks of water-brash, is this: that from some preternatural irritation of the stomach, such as the persistence of food in it, the collection of mucus, or morbid sensitiveness of the nerves, the same salivary secretion in the gullet which ordinarily accompanies meals continues afterwards, and is prevented from proceeding downwards by an irritated constriction of the muscular tube. After a time it is ejected, and the result is attained by that easy reversed action which is observed in the œsophagus, as distinguished from the severe strain of emptying the stomach by vomiting: and hence we have the easy eructation of mild fluid constituting an attack of the symptom in question.

Water-brash may occur at all hours of the day; but in its purest and most distinct form of an eructation of limpid fluid, the morning, when the stomach is emptiest, is the most usual time for it; at other times it is very commonly mixed with the acid gastric secretion.

The above explanation refers, in short, water-brash to a spasm of the œsophagus detaining the saliva from proceeding into the stomach, which is enabled during the absence of food to collect that secretion in considerable quantities, and throw it up by a simple reversed muscular action.

A morbid sensibility accompanying spasm, and running in the same direction, constitutes the "heart-burn," which occurs along with water-brash. It must not however be supposed that it is any acrid, alkaline, or acid quality of the fluid ejected that causes the pain. A simple evidence of this is exhibited by getting the patient to swallow again the fluid which rises into the mouth. Of course if it was capable of giving pain by its chemi calconstitution, it would do so in going down as well as in coming up. But nothing of the sort is experienced, and it excites as little discomfort as saliva in its downward course. Besides which, heartburn occurs without water-brash; indeed, it is by far most commonly dry, consisting only of a sensation like hot smoke rising in the throat, but bringing nothing up. In these cases, the most familiar ones to us all, either the spasm is not complete enough to stay the descent of the saliva, or not strong enough to bring it up, or that secretion has been exhausted by the recent digestion of a meal. Hence heartburn may be looked upon as the milder disease, of which water-brash the severer development. It occurs during the later periods of digestion as a consequence of overloading the stomach or eating improper food, even to moderately healthy persons, whereas pyrosis is confined to chronic invalids.

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* Kölliker, *Mikroskop. Anat.*, § 157.

Heartburn, or spasmodic pain in the œsophagus, must not be confounded with pain in the epigastrium or in the abdomen. The latter is a consequence of the immediate presence of that which excites it, and is felt at the actual seat of its cause; whereas heartburn is a sensation conveyed up the nerves of the tube, and does not arise from anything in the tube itself, but from morbid conditions of the neighbouring stomach. Heartburn is analogous to pain in the urethra, and epigastric distress to that in the kindeys themselves from renal calculus.

Epigastric pain occurs very commonly directly after food, or even during the meal: it comes on immediately that which is to produce it has got to the seat of disease; whereas heartburn requires the morbid cause to have been some time existing before it gives notice of its existence: there are probably several links in the chain which connects it with the state of stomach, and so it commences only during the middle and later periods of digestion, or after that process has entirely ceased.

The causes of heartburn and pyrosis, though they are diseases *of* the œsophagus, do not lie *in* the œsophagus. Cancer, ulceration, or stricture of that organ, do not originate them in the majority of cases of these lesions, whereas they are a very common consequence of even slight morbid conditions of the whole stomach. It is to be remarked that they are easier produced by slight general states than by more severe local states of the viscus. Then we constantly find cancerous tu mours and considerable ulcerations in the gastric walls without any œsophageal symptoms at all; whereas a catarrh, a mucous flux, and more commonly still, simple atony of the stomach, seldom exist long without them.

They are not, then, accompaniments of dangerous or fatal disorders, and for that reason may be said to have no morbid anatomy. We scarcely ever see the inside of an œsophagus that has suffered from them at any short period before death, except in cases of death by accident; for any distant severe malady seems to make all the minor evils.

As they may be dependent upon one of several internal states, or upon several united, the external circumstances which lead to them are of course many and various. But the links in the causation of the immediate phenomena are so numerous, and the local gastric condition has usually lasted so long before they are produced, that it is difficult in most cases to make out a very consistent history. Hence in systematic books long lists of very fanciful causes are usully assigned to them; in fact, the whole number of producers of gastric disorders in general.

These lists need not be repeated, partly because they are so long, and partly because, from their mixed nature, they lead to no practical deduction as to treatment. I think, however, that it is of importance to distinguish the morbid conditions on which pyrosis and heartburn depend, for the reason that they require different medicines and management. I wish this could be done with greater fullness, but yet the following aid to diagnosis may not be without its value. When they arise from the sour decay of the food, or simply distension of the viscus arising in atony of the stomach, they occur three or four hours after a meal, and often bring up acid matter in the eructations; when dependent on mucous flux, they are most apt to come on in the morning before breakfast, and the ejected fluid is neutral or alkaline.

Remarks on Treatment.

Heartburn and water-brash are well known to be capable of relief by a considerable variety of remedies, and those in some cases very discordant in character. The reasons are—first, that they are a disorder consecutive on a certain *degree* of derangement; and hence, if that degree be lowered, they vanish, even without the derangement itself being entirely removed: then, as they are dependent on the sensitiveness of a part not itself the seat of morbid change, they may be cured by diminishing that sensitiveness, the morbid change in the distant part remaining the same: then again, they are not in most cases constant, but excited only by certain untoward circumstances of diet, &c., and may be prevented by avoiding those circumstances, the condition of the body yet being unaltered.

The practical inference to be drawn is, that in order to prevent a recurrence, curative remedies should be continued for some time after the symptom has gone away, and that merely palliative measures—that is, those which blunt the sensitiveness of the œsophagus—should be adopted only temporarily, and in cases of extraordinary distress. We should remember that by these palliatives we are putting out of our cognizance a test and measure of a more obscure disorder; we are shutting our eyes to the evil, not removing it.

When the pain is not very great, alkalies—such as carbonate of soda, potash, and chalk—afford a considerable temporary relief. They do not act by neutralizing acid, as the ordinary phrase runs, but by blunting the sensitiveness of the œsophageal and gastric nerves, just as lime-water, soda, borax, chalk, &c., will allay the pain of the skin inherpes or in an irritable blister. There is no positive evidence that there ever is an over-secretion of acid in the stomach, or that the stomach is pained by the acidity of its contents; and besides, these drugs, when in large doses, give relief even where alkaline and neutral matters are ejected. They are, in fact, anodynes; and like all anodynes, they have the inconvenience that they require the frequent augmentation of the dose to keep up the same degree of efficiency. Given merely as palliatives, alkalies contribute little towards cure. If intended to produce the latter effect, their administration must be much more frequent than the paroxysms demand.

Of palliatives to excessive pain, the best, because the best known and most manageable is opium. It relieves the immediate pain and spasm, and when joined with an astringent, as in the compound powder of kino, gives a degree of tone to the œsophagus, and perhaps to the stomach too, which certainly is a step towards cure.

Where there is a relaxed, unhealthy state of membrane, either actually pouring out an excess of mucus, or disposed to do so, indicated by the tongue and general condition described under Mucous Flux, there are no remedies which do so much good as trisnitrate of bismuth. This medicine has failed in acquiring a character equal to its merits from people contenting themselves with too small quantities. It is true that the ordinary dose of ten or twelve grains often is sufficient, but very often it is not, and then half a drachm or even a drachm may be given without danger, and frequently with the best results.

After a time, kino and bismuth may be combined together, and acting, it may be supposed, in different ways, seem to produce a compound good result, where each separately has perhaps failed. The doses of neither require to be diminished when they are combined.

In obstinate, long-protracted cases, nitrate of silver is very useful, especially where pyrosis is combined with wearing pain in the epigastrium, lasting through digestion. Half a grain, three times a day, may be continued for a month without danger of blackening the skin. Or it may be given, morning and evening at the same time that kino and bismuth are taken in the day.

In cases of atony or sluggishness of the stomach, either from anæmia or mental causes, such as anxiety, overwork, &c., if heartburn or pyrosis arises, it is best treated by such remedies as relieve the general condition of the alimentary canal. As this seldom exists without a tendency also to the last named state, the same remedies are to a certain extent beneficial here, but at the same time it effects a more complete cure to join with them some specially suited to these cases. Hence we find among the remedies enumerated for heartburn, iron and nux vomica, both adapted for atony of the stomach, as will be stated in a future page: the first when it arises from anæmia, and the second from muscular or nervous debility.

It would lead to vain repetition to detail here the diet and hygiène indicated by heartburn and water-brash; they are, in fact, the diet and hygiène proper for the conditions of stomach producing that symptom, and will have to be entered into in the next Chapter.

CHAPTER IV.

MORBID AFFECTIONS OF STOMACH.

It may be observed that the marked feature of the stomach's duty, is that of retaining for a time the alimentary mass with as little inconvenience to the individual as possible, and mixing it up with a peculiar solvent, in fact, *easy chymifaction*. Keeping up the physiological mode of looking at disease adopted in this volume, it will be with reference to the injury inflicted on this function that faulty states of stomach will be considered. In the first part of the chapter will be included the principal morbid states of the organ as evident to observation: in the second part, the morbid acts consequent on these states.

PART I.

MORBID STATES OF THE STOMACH.

The altered states of the stomach, discussed in the following pages will be entered into only so far as they affect digestion. Their essential nature is a part of general pathology. Those of chief interest seem the following; of an *acute* character:—

Common inflammation, or gastritis;
Catarrh, or "bilious attacks;"

Chronic:—

Mucous flux; Excess of gastric juice; Deficiency of gastric juice;	Where the secretion is faulty.
Degeneration; Ulcer; Cancer and other mechanical impediments; Dilatation.	Where a structural change of the solids is to be seen after death.

SECTION I.—*Gastritis.*

Acute inflammation of the mucous membrane only in the stomach, except as a consequence of the ingestion of corrosive poison or boiling water, is a very rare disease. I must say I never saw a case I felt sure of; certainly never one confirmed by a *post-mortem* examination, where one of the above-named causes were not present. It is to be presumed, however, that when idiopathic gastritis makes its appearance, it will have the same aspect as that which arises from a mineral acid, arsenic, or hot water.

The symptoms, when caused as aforesaid, are very severe, even when they do not finally prove fatal. There is excessive tenderness of the epigastrium, so that the weight of the bed-clothes can hardly be borne. There is such excitability of the stomach, that the ingesta are rapidly vomited. Respiration is quickened and catching, without any corresponding cause being discoverable by auscultation. There is great restlessness and anxiety, contraction and distortion of the features, and prostration of strength. The agitation, dyspnœa, restlessness, and thirst keep increasing; hiccup greatly aggravates the patient's sufferings; the extremities become cold; and in some cases delirium and jaundice supervene.

If the patient dies, the stomach is found altered in colour, being of a dark purple-brown instead of a rose tint, and in parts is brownish-black, with the mucous coat separating in strips which have a gangrenous appearance. It seldom, however, has a gangrenous smell. It is not probable that a person should recover from such a state of things as above described. The stomachs that get well have probably no loss of substance, and only local reddening of the surface. Yet how severe the symptoms even in these! and how unlikely that sthenic inflammation, if it really often occurred in the stomach, should be passed over!

Local acute inflammation of the whole walls of the stomach, peritoneal, mucous and fibrous together, is not a much more common disorder. I believe there are only two in the *post-mortem* examinations of the ten years from 1841 to 1851, at St. George's Hospital; one a patient of the late Dr. Hope, and one of the late Dr. Macleod.* There were flakes of fibrin, and fluid, with some recent adhesions, in the peritoneums of both. There were spots of effused blood and brown patches on the internal surface of the viscus; the mucous membrane was very much thickened, and pulpy; the cellular tissue, too, of the walls was thickened, in one being nearly one-third of an inch thick, and containing a deposit of fibrin of recent appearance in its substance. In both it was remarked that the gall-bladder was much distended. Both had severe pain in the epigastrium and vomiting, and in one the inflammation seemed to be caused by granular degeneration of the kidneys.

Of such rare diseases, it is clear there is not much to be said.

SECTION II.—*Catarrh.*

Catarrhal affections of the stomach are as common as pure gastritis is rare. In their milder forms they constitute what are usually termed "bilious attacks," in their more severe they are "gastric fever," "bilious fever," &c. They take the epithelial form of catarrh:† there is a great excess of epithelium on the surface of the membrane, as is seen on the throat and tongue; it is much more sticky and adherent than usual, and causes a bitter sensation in the gustatory nerves. There is a feeling of oppression at the epigastrium, giddiness, and headache (the latter sometimes constituting such a marked feature of the disease as to cause it to be called "sick headache"), nausea and loss of appetite, vomiting, slight thirst, and sometimes, but not always, increased rapidity of pulse.

The French term, "*embarras gastrique*," for this disorder is really very correct in a pathological point of view, for "embarras" is the vulgar and very expressive word for a cold in the head, and to associate the two forms of catarrh together is just and convenient. The English word "stoppage" is, in some parts of the country, used in the same sense, but is not common. However, practitioners ought to know that it does not mean "constipation," as might have been imagined.

As in all catarrhs, so in gastric, there is a great tendency to recurrence; and a person who has had a bilious attack once, is from that fact more likely to have a second from slighter causes.

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* *St. George's Post-Mortem Book*, 1841, fols. 27—86.

† See p. 241.

When there is much fever, it is often called "gastric fever," and then it becomes of more consequence, though never in this country deserving the character of a dangerous disorder. The symptoms before named are here much more marked; there is more troublesome vomiting, and pain in the epigastrium; the skin is hot and dry; the urine dark, and sometimes thick, from a deposit of lithate of ammonia; the pulse full, hard, and quick. The symptoms, like those of all catarrhs, both topical and febrile, remit in a decided manner in the morning, and are again exacerbated towards night, from which circumstance this has been called "*remittent* fever." In ordinary cases there is constipation, but occasionally diarrhœa occurs, and if it be severe it is apt to end in typhus, and sometimes in a fatal result.

The prognosis of gastric fever is in general favourable. The circumstances which mark this are: 1. The mild character of the fever. 2. The distinctness of the remissions. 3. The absence of pain in the belly. 4. Constipation. On the other hand, alarm should be excited: 1. By the fever being excessive, or with a tendency to become typhoid. 2. By its being continued without intermissions. 3. By there being pain, tumefaction, and rumbling in the belly. 4. By diarrhœa, in proportion to its continuance.

The frequency with which bile is vomited, and the frequent appearance of large quantities of bile in the diarrhœa of gastric catarrh, have acquired for the disorder the popular name of a "bilious attack." It is caused probably by an extension of the catarrhal state to the duodenum, or perhaps even to the gall-ducts themselves, and so to the whole substance of the liver.

The little help which morbid anatomy affords to the pathology of gastric complaints, seems to show a connexion between the acute diseases of stomach and liver. Thus it was specially remarked in the two instances quoted of the rare disease, inflammation of the stomach, that the gall-bladder was excessively distended with bile. So that it is not going too far to imagine that such a connexion exists.

The nature of the affection of the liver we have not much guide to; the analogy of what we see as the effects of catarrh elsewhere, renders it likely that there is an increased secretion of mucus from the gall-ducts which mixes with the bile, and makes it unsuitable for reabsorption in the intestinal canal, at the same time that the absorption is further impeded by the augmentation of mucus throughout. The bile then regurgitates into the stomach and excites vomiting, or else passes away by a diarrhœa.

Whether the bile is secreted in increased amount during these attacks, is difficult to pronounce absolutely. The probability is that it is not, for we constantly see, in patients with gastric catarrh, who are vomiting considerable quantities of bile, the same dull greenish tinge of the skin which is observable in jaundice from obstructed ducts or atrophy of the liver, when unquestionably the coloured elements of the hepatic secretion are retained in the blood. All we have evidence of is, that there is an excess of unemployed bile in the alimentary canal; but it is more likely that such excess arises from non-absorption than from increased formation.

Remarks on Treatment.

A slight "bilious attack" will get well of its own accord and do no harm, if the patient will only follow the indications of nature—namely, to keep quiet, starve, and lie down. At the commencement of the disorder, when it may rather be said to be imminent than to be present, a quickly-acting purgative will so much relieve the distress arising from the congestion of the portal system during the attack, that it is lightened very much, and in those who are subject to the complaint such a dose is a prudent proceeding. The violence of bilious attacks may also be diminished by a continued course of such mild purgatives as produce an increase in the solid fæcal matter evacuated, indicating increased destruction of the effete tissues. The best is aloes, a nightly dose of which, to just sufficient extent as to make the evacuations bulky but not frequent, will diminish gradually the violence of bilious attacks.

Some people fancy that taking purgatives increases the frequency of bilious attacks, though it alleviates their symptoms. The fact is, that as people advance in years the attacks are apt to get more frequent of their own accord; and this must not unfairly be attributed to the remedies used. I cannot see any just cause to accuse purgatives of it.

Gastric fever is equally an acute disease tending of its own accord to get well, and therefore the treatment should be directed only to prevent its taking a bad turn and to relieve distress. Absolute rest and low diet are necessary; indeed, the patient cannot get about, and has no appetite. Effervescing salines relieve the vomiting and feverishness better than anything. But it must be remembered that the vomiting is an effort of nature conducing to cure, and it is not desirable to check it entirely. Indeed, sometimes where vomiting is wanting, good effect seems to be produced by the administration of an emetic. The severe headache is best alleviated by the application of a sponge wrung hot out of water, as hot as can be borne. The constipation requires the administration of a purgative, and as the stomach is in a state which rebels against drugs, it is best to give an enema (say of senna and Epsom salts), so as to produce the effect without troubling the failing organ.

The turn of the disease to end by the critical evacuation of effete matter, is hastened by small doses of hydrargyrum cum cretâ, with or without ipecacuanha.

SECTION III.—*Mucous Feux.*

Mucous flux, or as the Germans call it "chronic catarrh" of the stomach, bears the same relation to acute catarrh, or "bilious attacks," that chronic bronchitis does to influenza.

As chronic bronchitis seldom commences with the corresponding acute complaint, neither does gastric mucous flux in most instances commence with bilious attacks.

Chronic bronchitis and gastric flux resemble one another further in this,—that *in the adult* they are seldom idiopathic, being generally dependent upon some mechanical lesion affecting the neighbouring circulation of blood—such as tubercle, emphysema, diseased heart: or some blood disease—such as uræmia. In *children*, however, this is not the case; chronic flux of all the mucous membranes, especially bronchial and gastro-intestinal, occurring not uncommonly alone, and by no means indicating organic disease.

In the mucous affections induced by hooping cough, it is interesting to see how commonly the two systems, gastric and bronchial, are disordered together. An emetic or spontaneous vomiting brings up a quantity of glairy mucus (evidently not swallowed, for it is in a homogeneous mass, and not disunited, like mucus which has been floating in fluid), and not only are the gastric discomforts, but also the chest symptoms, simultaneously relieved for a considerable period.

We have the corroborative evidence of morbid anatomy, that the two corresponding states of bronchi and stomach are often associated together. In a table published by Dr. Handfield Jones in the Medico-Chirurgical Transactions,[*] of 100 examinations of our fatal cases at St. Mary's and St. George's, there are twenty-five instances of an excess of mucus adherent to the walls of the stomach.[†]

Of these twenty-five—

6 had tubercles or vomicæ in the lungs as chief cause of death,
4 had diseased hearts as chief cause of death,
7 had œdema or emphysema observed after death, or chronic cough during life, as chief cause of death.

In the above seventeen it may be considered self-evident that there was an increased secretion of mucus from the bronchi as from the stomach.

Of the remainder—

4 had diseased kidneys as chief cause of death,
1 had pneumonia as chief cause of death, where chronic cough was not an unlikely thing.

Of the remaining three—

1 had cancerous, and
1 tubercular disease of the peritoneum (whose local irritation are sufficient to account for local mucous secretion, as tubercle in the lung accounts for bronchitic secretion).

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[*] Vol. xxxvii., p. 86.

[†] Viz., numbers, 10, 11, 24, 27, 33, 34, 35, 36, 45, 48, 54, 57, 58, 62, 66, 67, 71, 72, 74, 75, 77, 80, 93, 94, 99 of the table. In number 33 the fact of the great excess of mucus has been omitted by error, but as it was a patient of my own, I have ventured to interpolate the fact.

1, a child of four months, had inflammation of the bowel and the mucus was an evidence of gastric fever, not c chronic flux.

No further evidence beyond the above quoted facts i required to establish the law, that, *where there is excess of mucou secretion in one system of mucous membranes, there is a correspond ing tendency in other systems, even though the former should aris from purely local as distinguished from general causes.*

Hence, experience shows that the most common cases i which to find mucus secreted in excess in the stomach, ar either those of absolute organic disease of the viscus itself, o else those which induce bronchial flux—as tubercular affection of the lungs, emphysema and dilated heart. Alone it appear to be very rare.

Where the mucus is collected in excess in the membrane there is usually found after death more or less congestion o the capillaries, and even of the larger bloodvessels; and ther is sometimes yellow or dark-brown matter, looking like exude blood, mixed with the mucus. But the glandular tubes ar usually healthy or only accidentally diseased, and indeed ther does not seem to be any other material alteration in the membrane beyond the congestion essentially joined to mucus flux.

The probability made apparent by the above observation that gastric mucus is generally traceable to some corporeal alterations, does not quite render superfluous the discussion o causes external to the body. There remains to be investigate the reason why in some cases the stomach should become affected, and in others should escape.

Are there any habits or occupations which induce the disorder? I must confess I much doubt whether we can justl accuse of this evil any of the more notorious vices which one i always glad to fling a stone at. Gluttony and drunkennes have not in my experience brought on the symptoms, nor hav the stomachs of those addicted to them exhibited after deat more mucus than others. Smoking brings on dyspepsia, bu not of this sort.

On the other hand, the constant sipping of weak potation especially tea, has seemed to me in some cases to be the caus of gastric flux; at all events the patients have been better fo leaving off the habit. Indolent sedentary persons seem more subject to it than others, females more than males, and the middle period of life, from forty to fifty, more than any other age.

One peculiarity I have rarely failed to notice in patients thus affected—viz., that they have been of a desponding, easily depressed turn of mind, not absolutely melancholic, but disposed to dwell always on the gloomy side of everything, external or internal. The first impression is, that this disposition is a consequence of the complaint, but on inquiry it will very often be traced to a period long anterior to the ill-health and proved innate. When I see the great influence which the mind has over the stomach, even over its secretion and motion, I can hardly fail to attribute some influence in fixing this disorder on the organ in question, to mental causes of a painful character, such as anxiety, disappointment, ill-requited affection, &c.

The pressure on the epigastrium used by cobblers, and that which females who lean forward for needlework with ill-fitting stays, often are subjected to, for so many hours daily, does not probably injure the perfectly healthy stomach. But when it is joined to cold, ill-ventilated rooms, draughty, and at the same time fusty workshops, long abstinence, sloppy, innutritious food, and the bronchitis, heart disease, consumption, degenerate kidneys, &c., which follow in the train of these unfortunate circumstances—then indeed it is injurious, and probably helps to fix the disorder on the part pressed.[*] Hence needlewomen and tailors, ground down to low wages as they are, depressed, bullied, and cooped up in unhealthy garrets, are much more subject to gastric disorders than bootmakers, in spite of the extraordinary pressure to which the waists of the latter are exposed. The proverbial jollity and mental activity of the trade perhaps has something to do with keeping off an evil which the work would seem to lay them open to.

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[*] My experience as a member of the Industrial Pathology Committee of the Society of Arts leads to the opinion, that in all handicrafts nine-tenths of the evil accruing to the workmen arise from bad ventilation, and that the greater part of the remaining tenth might be easily prevented by the observance of cautions familiar to educated persons, and indeed adopted by all humane masters.

It is by no means the later stages of pulmonary lesions with which gastric flux is most commonly associated. In tubercular lesions especially, the first thing for which a medical man is consulted is often a peculiar kind of "indigestion," sinking at the epigastrium, craving for food (which is disliked when eaten), occasional vomiting, a feeling of weight arising from congestion in the abdomen, irregularity of bowels, &c. These indeed may be traced to the stomach; but on close inquiry, a history of morning cough, perhaps hæmoptysis, and an hereditary tuberculous taint in the constitution, is usually to be elicited, referring the inquirer to the true fountain of evil. In fact *some* lung symptoms almost always precede all the other signs of consumption, but are frequently passed over, either because they have not attracted the notice of the patient, or because he would fain deceive himself into the notion of their being of no consequence.

As pulmonary disease goes on, there are several causes for the abdominal symptoms subsiding. The pectoral lesions may have got so much worse as to force themselves more on the patient's attention, other things remaining the same; or perhaps they may really relieve the other mucous system. Then the medication absolutely demanded by the friends for—what they view as the most important part—the chest, may benefit the stomach; rest, milk diet, mild air, are just the things for it. Or perhaps the body gets used to its morbid state, and the excess of mucus causes less inconvenience. Then consumption gets regularly established, and the indigestion is looked upon as the precursor of pulmonary tubercle, instead of as a symptom of the first stage of its existence.

Cause or no cause, precursor or symptom of the first stage of phthisis, it is certain that gastric disorders very much aggravate it, and prevent the body from taking in that amount of nutriment which alone can enable it to bear up against the lesions: so that the most desperate cases of consumption are those which have manifested gastric symptoms at the commencement, and continued them while the disease got worse; and the most curable are those which are least complicated throughout. There is therefore every reason for paying attention to the stomach early.

The symptoms of gastric mucous flux seem to be closely proportioned to the quantity of mucus secreted, and consequently the extent of membrane involved. Where that is moderate, and where there is yet remaining enough to continue the business of the stomach (as in most of the cases recorded by Dr. Handfield Jones),* the difficulties in digestion are so slight as to escape notice, if there is at the same time any more severe affection to attract the patient's attention. There may be only a certain want of appetite and nutrition, and an incapacity for benefiting by the food taken, in no way distinguished from similar symptoms arising in general anæmia and atony. But where the whole or greater part of the stomach is covered with mucus, and enough is collected to interfere with the action of the gastric juice upon the aliments, phenomena of a well-marked character manifest themselves. There is then a sensation of uneasiness, scarcely in the majority of cases amounting to actual pain, in the epigastrium, coming on most at times when the stomach is empty. It is first accompanied by a craving for food; but no sooner is any taken than it excites a feeling of weight and distension within a very short time, often only relieved by actual vomiting. Where, however, the pain arising from the food is rendered very great by excessive sensitiveness, then there is often a disgust for eating, and an idea that the craving is a false sensation:† so that the patients will say that they have no appetite, but that there is an emptiness and "sinking" in the stomach. Strictly speaking they have a desire for food, but this is accompanied in sensitive persons with so much nausea and disgust, that they refuse to recognise it as related to healthy appetite; and this fact may usually be made out in conversation with intelligent patients. In the empty stomach there often collects a considerable amount of mucus, which excites vomiting without any other stimulus; so that at times quite remote from meals, such as in the morning a large quantity of glairy fluid is thrown up, with great relief to the nausea and other uneasy sensation.

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* *Medico-Chirurgical Transactions*, vol. xxxvii., p. 109.

† The cause of this craving is probably that the nerves of the stomach glands and other parts concerned in the secretion, are brought by mucous flux into the same state as they are by hunger, without being able to relieve themselves by pouring out the juice. Hence the craving cannot be called a "*false sensation*:" the sensitive nerves are not in fault, but the mucous membrane which has deceived those nerves.

There is sometimes considerable distension of the stomach by flatus, and a sensation of spasmodic constriction when the stomach is empty, especially on lying down in bed at night or in the morning before breakfast. Indeed the recumbent posture seems to be particularly unfavourable in cases of gastric flux, and the nocturnal symptoms are often capable of relief by the simple expedient of sitting up.

There is almost always constipation, and the motions passed are dry and lumpy (unless purgatives have been taken), but accompanied from time to time by a good deal of mucus. The urine is clear, and of low specific gravity, and sometimes, whether accidentally or not I cannot say, contains more mucus than usual.

There is often a good deal of thirst, but no heat of skin or other marks of feverishness, and the sensation is in fact much akin to the peculiar hunger just noticed, receiving little relief from the gratification of the desire.

In cases of long duration there is a dull leuco-phlegmatic aspect, a feeling of weakness, cold extremities, small, feeble pulse, and in the female sex deficient catamenia. The matters vomited are of very various description: sometimes they consist solely of the food taken, in a state of acid fermentation; but it is rare not on some days to find a quantity of mucus, acid or alkaline, in long stringy masses. When the vomiting occurs at periods remote from meals, there is sometimes no food at all in it, but merely a quantity of glairy fluid: as if the exertion of passing onwards the alimentary mass had filled the stomach with mucus which it then rejects.

Sometimes the microscopic mould called *sarcina ventriculi** is there in great quantities. And often in that case, this proof of a long duration of the substance in the stomach is confirmed by their being frothy and mixed up into an homogeneous mass like fermenting yeast.

It was at one time thought that the sarcina was a cause rather than a consequence of the disorder. But I think its position when detected *in situ* is a sufficient proof to the contrary. If it excited the flow of mucus, it would surely be buried in, or at least attached to, the membrane, like the itch insect in the skin, or the cryptogamous spores in ringworm. But such is not the case, for as far as I have been able to ascertain, it is *always* found lying quite in the external layer of mucus, and never amongst the glands.* In this position it can have no influence over the mucous membrane, and I think proves itself to be not a disease, but the accidental parasite of a disease.

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* So called, not because it is a *burden* (*sarcina*) to the stomach, but because it is divided into quarters by two constrictions crossing at the centre, like a *parcel* tied with a string in the usual way.

Under the same category as sarcina some would include an animal parasite, the large round worm often vomited from the stomach. The creature would certainly never be able to retain its place unless the eggs had been hatched in a layer of tough, permanent mucus, and there were a continuous succession of this substance for it to hold on by. But then we see that it has, like a fish, an instinctive propensity to work up stream, and would find no difficulty in passing the pylorus, through which, as is well known, bile often regurgitates; so that it is more likely to be bred in the ilia, where its eggs are found,† than in the stomach, where they are not. Therefore I do not think the round worm any proof of gastric mucus, though it rarely exists without that state of intestines.

Gastric flux is sometimes accompanied by a similar condition of the intestinal mucous membrane, and then there may be diarrhœa, or at least great irregularity of bowels. And as in the stomach, sarcinæ, and perhaps round worms, find a home in the mucus, so lower down all the varieties of intestinal worms may appear, especially in children or adults of a soft leuco-phlegmatic (or as it might be called "mucous") constitution.

The appearance of the tongue in gastric flux is very variable, so that it is not a safe index of the disease unless many circumstances are taken into consideration. Most commonly, it is coated with only rather a thicker layer of epithelium than ordinary, so as to present nothing very remarkable in its appearance; in other cases it is wet and glazed, and sometimes has broken flakes of very white epithelium spread about it. Sometimes it is red and raw, and looks as if it had lost its epithelium altogether. In these last there is generally a good deal of disorder in the salivary glands, and I am disposed to attribute to them this and several other inexplicable varieties of tongue. In recent cases the groundwork of the tongue is red, but in long protracted ones it becomes pale and flabby.

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* Strikingly exemplified in a patient of mine, in whose vomit during life *sarcinæ* were frequently looked for, and could never be detected; but where they were found in great abundance after death, on the surface of the mucus, as above described.

† Wedl, *Pathol. Histologie*, fig. 190, p. 785.

It was pointed out at the beginning of this section that mucous flux seldom, if ever, derived its origin from acute catarrh or bilious attack. Yet there is a relation, and one, too, of cause and effect, between the two diseases. Persons with gastric flux are much more liable to bilious attacks than others, and not uncommonly the condition of the stomach is first brought to the notice of the medical attendant by this liability. This is quite consistent with what we know of the nature of catarrh in other mucous systems. A person with chronic bronchitis is much more likely to catch cold on the chest than others, and chronic dysentery disposes to attacks of acute diarrhœa.

It is very common for food enveloped in mucus, and unable to be penetrated by the gastric juice, to take on an acetous fermentation, and to produce acid eructations, heartburn, and pyrosis of the œsophagus, and a painful collection of wind in the stomach, so that the distress resulting is of a spasmodic character, and appearing to be relieved by the passage of the wind, is attributed solely to that cause. I find it, however, difficult to believe in idiopathic spasm or idiopathic flatulence of the stomach.

This tendency of food to turn acid on the stomach, and lie there as a mass without being chymified or passing onwards, is particularly common in persons with hereditary gouty constitutions. I believe the pathology of it to be a slight flux of mucus, deficient gastric secretion, and yet a vigorous, sometimes even excessive appetite. Hence they have not that check of failing desire for food which makes the meals of other invalids moderate, and eat more than their imperfect gastric juice can digest. This is a simpler and therefore more probable explanation than the usual chemical talk about uric acid, &c., which might be substituted for it.

Remarks on Treatment.

The measures I have found most useful in cases of gastric mucous flux are the following:—

1. *Alkaline Milk Diet.*—There is probably no form in which nutriment can be so easily taken up by the mucous membranes as milk. But in a disordered state of the stomach it is very apt to come suddenly on a quantity of accumulated undiffused acid, to be coagulated into a solid mass, and, enveloped in mucus, to pass through the alimentary canal unaltered. The best way to avoid this is to guard it from coagulation in the stomach by adding about a fourth part of its measure of lime water. It then probably does not require the gastric juice at all, but passing liquid through the pylorus is there digested by those powers which the researches of Drs. Bidder, Schmidt, and Grünewaldt have claimed for the intestines.

Alkalizing the milk therefore *rests the stomach*, by not requiring its solvent services.

It is not, however, wise to fill the alimentary canal with a quantity of sloppy food all at once, and I have found that the most judicious way, in bad cases, is to forbid all regular meals, and to get the patients to take the milk at short intervals in small doses, so as to have about two quarts, or more, according to taste, during the day. A captain's biscuit or two, thoroughly soaked in milk and water, is the best bread food, and that too should be taken in small quantities at short intervals.

2. *Mercurials.*—Hydrargyrum cum cretâ in small doses, just sufficient not to act as a purgative, but to promote interstitial destruction, appears to do good. The action probably is the depuration of the blood, which the collection of mucus must impede by stopping secretion. But half a dozen doses, one every night and morning, are usually enough. Stronger mercurials and a long continued course, do harm

3. *Hyposulphite of Soda.*—The use of the akaline subsalts of soda, especially of the hyposulphite, or a draught of the sulphate of soda with bicarbonate, as recommended by the late Dr. Barlow,

of Bath, is of decided use in gastric mucous flux, especially where it is so copious as to occasion vomiting. But they must be given in rather larger doses than usual. From ten to fifteen grains of the hyposulphite three times a day is as little as I have found do good. The benefit of this treatment is most marked where there is much vomiting.

4. *Kino.*—It may be presumed that the good which this drug does depends on its astringent power over the mucous membranes. It is certainly of great use in cases where gastric flux is complicated with pyrosis, and where there is pain at the cardia. In these cases, even when joined to opium, it does not produce constipation: sometimes, indeed, it relieves that symptom by removing the general state of irritability and discomfort, and perhaps by checking the discharge of mucus.

5. *Ipecacuanha.*—As a vomit occasionally, ipecacuanha is useful by giving other remedies a fair start. It certainly clears away the mucus for a considerable time. But it must of course be backed up by other remedies.

I have not, however, found benefit to arise from smaller or repeated doses of this drug. In spite of its specific action over the stomach, it has not the same good influence over the mucous membrane of that viscus that it has over the bowels in chronic dysentery.

Purgatives I have always found to make the patients worse in the end. But if they are necessary from constipation exciting anxiety, jalap seems to act with less distress and griping than senna, and brings away a large quantity of mucus.

Bathing does do not do any good in well-marked mucous flux, either in the form of shower bath, swimming, or sea-bath. The only cases likely to receive benefit are those where there is joined with it great atony, and no congestion of the internal viscera.

Nitrate of silver has disappointed me; probably it is too rapidly neutralized by the chloride of sodium in the secretions to touch the mucous membrane effectually.

Bitters and tonics, if given before the disorder has received a decided check, seldom do good; and they very often convert the mucous flux into an irritable, painful or neuralgic dyspepsia. They are not much wanted, even during convalescence, for well-selected "kitchen-physic" is usually the most effective tonic that can be given. The best way is to continue them for two or three days only, just to show the patient he has got an appetite, and then leave them off again.

Hydrocyanic acid very often refuses to check the vomiting in gastric flux, and seems to be useful principally in those cases where the disorder is kept up by the irritable condition of the nervous system of the stomach, marked by the prominence of pain as a symptom. Here indeed it is useful for checking both vomiting and pain.

It is not possible or desirable to continue the alkaline milk diet for long. Directly an improvement has begun to take place, broth and beef tea should be allowed, and then a gradual return to digestible meat, such as oysters, fish, poultry, once-cooked mutton chops, and fresh venison. The great art is to get down as much nourishment as possible without loading the stomach; and that end is best accomplished by small and frequent relays of easily digested food.

It is a most important object to the future well-being of the patient to restore the stomach to a natural condition. If it is the only deviation from health, then of course the advantage is obvious; and even in cases where the real danger arises from another organ—as for example in injuries to the lungs or heart—the being able or not to digest albuminous food is often the turning point of life overcoming the lesion, or the lesion overcoming life.

SECTION IV.—*Excess of Gastric Juice.*

It has always appeared to me very doubtful whether excess of gastric juice can ever be truly predicated of any state of system. There is often certainly a collection of acid in the stomach, which is accompanied by pain or distress, and as the gastric juice is acid, it has been taken for granted that this is gastric juice in unnatural abundance. But if it were really so, it could hardly help performing its duties in excess too, and digesting with great energy and rapidity. Such however is not the case, these instances of "acidity of stomach" being notoriously those distinguished by slow, and sometimes absolutely arrested digestion. The most probable explanation of such cases is, that the food not being penetrated and dissolved by the gastric juice, takes on butyric lactic, or acetic fermentation as a mass; and that this quantity of acid matter, surrounded by a layer of insoluble mucus, acts as a foreign body, and excites the distress felt. It seems highly probable that in many of those instances there is a deficiency, rather than a too copious supply of the real solvent.

The cases which seem most like a superabundance of this secretion, are those where there is very great liquid vomiting, —an ejection of more fluid matters than have been taken in. This does sometimes occur, especially as a symptom of acute disorders, and then truly enough there is more than is wanted, more than is taken up by absorption; but still the excess is relative, not absolute, and it is the non-absorption which is the important point for consideration.

SECTION V.—*Deficiency of Gastric Juice.*

From physiological reasoning and the observations of Dr. Beaumont, the signs of the deficiency of gastric juice may be considered to be—

1. An arrest of the food in the stomach.
2. Distress after eating albuminoid substances.
3. Decay of albuminoid substances in the alimentary canal, and consequent fetid gases arising from that decay.
4. The appearance of unaltered muscular fibre in the stools.

The observations of Dr. Beaumont have long ago taught us that the said deficiency is the consequence of many things familiarly known as the causes of temporary indigestion. Anger, excess in alcohol and overabundant meals, are described as increasing indeed the redness and congestion of the mucous membrane, and also the quantity of mucus, but as diminishing the secretion.

Want of the natural stimulus, such as occurs during abstinence, appears also, from the experiments made at Derpt, to have a similar effect.

The febrile state, fatigue, mental or bodily, strained attention of the mind, grief, exposure to great heat or cold, are well known to dry up the membranes of the mouth, and therefore they may rationally be concluded to diminish that secretion of the stomach which resembles them in its great abundance of water.

The effects of anæmia are more doubtful. We certainly do not as a rule see aqueous secretions diminished by the want of red particles in the blood, or by weak circulation in the vessels. In some cases they are even augmented, as for instance in hysterical chlorosis, and in the early stages of uræmic anæmia from Bright's disease, where the water secreted by the kidneys is more copious than natural. Yet still the quantity of solid matter therein is diminished, and we may fairly view a lessening of the excretion of those substances which arise from the destruction of tissue as part of the consequences of imperfect blood. Under this category comes the gastric ferment, and therefore it is a reasonable inference that the juice is more or less deficient in this essential characteristic during anæmia.

Yet as long as water remains in its full quantity, so as to keep up the bulk, or nearly the bulk, of the gastric juice, an important item in its composition remains, and we have at any rate an agent which can carry the alimentary mass on by the peristaltic wave till it passes the pylorus, and then becomes subjected to the intestinal digestion. *Excess of water may compensate for deficient ferment,* as we see in the human stomach compared with the canine (see page 98), and perhaps in these cases there is some compensation in liquidity for loss of solvent effect in the gastric juice.

At all events the fact is, that we do not in pure anæmia and atony find the stomach so defective in digestive power as might have been expected. It is only when overloaded with too great a quantity of food at once that it rebels, and by judicious management of the times of eating we can get as much digested in the twenty-four hours as the heaviest outgoings require.

When, however, as a sequel to debility, or as a cause of it, there is also mucous flux and atonic congestion of the stomach, it is no longer a case of pure anæmia: circumstances are altered; the digestive power of the weakened gastric juice is still further interfered with by its not being able to penetrate the victuals, and so indeed some of the worst cases of difficult digestion arise.

When, then, in weakly patients there is exhibited *great* difficulty in the digestion of albuminoid substances, it is fair to conclude that there exists in the stomach some further lesion beyond mere anæmia or want of tone. But when the difficulty is of less moment, when it constitutes only an inability to digest large masses, while smaller give no inconvenience, it is probably the debility alone that has produced the inefficiency.

It is this latter sort of deficiency which is congenital in some individuals, who constitute one class of what are familiarly known as "poor creatures"—persons who, without any classifiable disease, are always over-exerting themselves, and are unable to live like their neighbours without failure. From deficient powers they are unable to digest at each meal enough to take the place of the usual interstitial destruction, and therefore if the outgoings are not limited or the incomings increased by special management, their tissues must suffer, and innumerable ailments arise as consequences of over-destruction.

They cannot form enough gastric ferment to dissolve the usual quantity of food taken at a meal, and therefore, unless its place is partially supplied by excess of water, the mass will not obey the peristaltic wave, remains in the stomach, decays, excites congestion and mucous secretion, perhaps establishes a chronic mucous flux, feels like a weight to the nerves, and is passed on covered with mucus, and so prevented from being digested in the intestines.

At the same time the gastric juice is further weakened by the saliva swallowed during the stomach's rest; it collects there in sufficient abundance, not indeed to do any serious damage when the juice is natural, but enough to neutralize a serious fraction of the small quantities formed by these patients now under discussion.

Deficiency of gastric juice has the additional bad effect of leaving in the system those matters which ought to be separated from it. For we must remember that secretions of all kinds have *excretive* uses as well as their more obvious duties as solvents to perform,—that the fluids which are turned to such good purposes consist of waste, useless, and hurtful substances injurious to the body when left in it. This is made clear by the consequences which follow the purely mechanical retention of secretions.

What, then, are the consequences of the retention of the gastric juice? I should be sorry to dogmatize on a subject confessedly so obscure, but looking at the acidity of the secretion, at the complex and varying nature of the acids it contains, and that there are classes of diseases—viz., gout and rheumatism in their Protean forms—distinguished by the presence of acid in the sweat, the flesh, the blood, and everywhere where it should not be,—that the gastric juice is a peculiarly colourless secretion, and that what is retained in gout and rheumatism is also remarkably devoid of pigment, as is shown by the clear complexions and red blood of the sufferers,—that in gouty and rheumatic persons such deficient digestion as I have described is peculiarly prevalent, and that an attack of these disorders is often preceded by an aggravation of the gastric symptoms,—taking, I say, all these things together, I cannot but connect the morbid physiology of these general disorders with the special retention of the secretions of the stomach, and their inability to be elsewhere excreted.

By far the most easily proved cause of deficiency of gastric juice is hereditary predisposition; there is no defect, moral or physical, so frequently handed down from parent to offspring, as the inability to form a sufficiency of this secretion; no "family failings" so common as the symptoms assigned to it in these pages. Other diseases do not much tend to produce it, and certainly no one particular class of diseases; so much so, indeed, that persons who when moderately well have suffered the inconveniences here described, are not unfrequently freed from them during illness.

Age is sometimes considered to be a cause of the symptoms detailed; but I cannot say my experience agrees with this opinion. I have very rarely seen an old person suffer in this way who has not had similar inconveniences before the turn of life, and the great majority of those who complain to us are of middle age. When elderly persons are troubled, it is usually through the agency of the external causes to be now noticed.

Of *external causes*, the commonest is overwork of the mind: long-continued anxiety, ambition, hard study, and, in short, any employment which calls for the continuous application of the intellect or the passions in one direction, induce more frequently than anything else the train of phenomena ascribed to this deficiency. For this reason it is a complaint found among "the busy hum of men," rather than in the "calm peace and quiet" of rural districts; rather among the classes who contribute the fruit of their brains than of those who offer the sweat of their brows to the common stock of labour.

Next to mental work comes gluttony, and next to gluttony drunkenness, as similar causes of the too early wearing out of the excitability of the gastric nerves, and consequent defect of secretion.

Remarks on Treatment.

Where we have reason to conjecture that there is a deficiency of gastric juice, we must spare the stomach as much as possible. If the causes of deficiency are temporary, such as an occasional indulgence in eating and drinking, a little starvation will do no harm.

But if the causes are of a more chronic nature, the patient may be not in a state to bear any starving or avoidance of albuminous food, and the disease may be aggravated by thus lowering the system. The best rules under these circumstances are—1. To let the albuminoid food be as liquid as possible. 2. To let the quantity requisite for the day's consumption be taken at frequent short intervals; and (if it is likely to turn sour), 3. To guard it with alkalies. Thus we may get it to pass unaltered into the intestines, and by trusting to their digestion, spare the stomach without starving the patient.

Though when taken *with* food or *after* food in cases of weak secretion, alkalies are almost invariably a relief, by preventing that acid fermentation which the absence of natural digestion gives occasion to, yet if taken *before* a meal they not only do no good but always aggravate the evils complained of. They appear then to augment the excess of alkali which already exists in the saliva swallowed, and neutralize the gastric juice as it is poured out. At such times, then, an exactly opposite course of treatment seems indicated, and is practically found successful. Acids, even when combined with indigestible substances, have been found an aid to digestion by habitual dyspeptics—as, for instance, sour apples, cherries, and the like, which Sir William

Temple recommends: but a safer plan is to take some soluble acid which brings no evil with it, such as a half a teaspoonful of vinegar in a wine glass of water, or a few drops of phosphoric or muriatic acid, so as to neutralize beforehand the saliva, and to give the scanty gastric juice full liberty to do its duty.

It will be found useful when recommending this treatment, to give our patient a short physiological lecture on the reason of it, lest we should seem to be blowing hot and cold, or trying experiments with his digestive organs, when we advise on the same day alkalies and acids to be taken as remedies.

The gastric juice may in part be replaced by water drank; and hence we often find a draught of this liquid, an hour or two after meals, will remove the discomfort arising from difficult solution of meat meals. It is not merely the dilution of pungent irritating matters which is effected by this means, but the solution and consequent absorption of the delayed nutrimentary mass.

The comfort arising from drinking a short time after meals has originated the custom of tea and coffee soon after the evening dinner. The liquids taken are, however, not nearly so well suited to the purpose as pure cold water is, and many sufferers from sluggishly secreted gastric juice will find from this latter beverage a relief which tea or coffee can never give.

The water may be made pleasanter by being iced, without any consequent injury to digestion, for we know from Drs. Bidder and Schmidt's experiments that the freezing temperature does not arrest the functions of the gastric juice,* and probably too the cold gives a tone to the stomach which its torpid congested condition requires.

Another addition to the water, not unpalatable, is a few teaspoonfuls of a solution of the superphosphate of lime,† which is at the same time a condiment or fillip to digestion, and a complementary food.‡

A lemon-water ice is another agreeable substitute for tea.

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* See p. 93.

† The solution referred to may be made by adding to the pharmacopœal solution of chloride of calcium the rhombic phosphate of soda, and then redissolving the precipitate formed by the addition of phosphoric acid. The chloride of sodium in the solution only makes it the more sauce-like.

‡ See p. 166.

An important rule in congenital or habitual weakness of digestive power, is that of resting before and after meals, so as at least to let no unnecessary disturbing circumstances arise. Ease of mind and body is of so much importance that nothing can supply its place. It is very common to hear bachelors complain, that when they dine in company their dinner gives them no trouble, they swallow all sorts of imprudent food, and feel no more of it; while a solitary meal at their club, on the plainest meat, is digested with difficulty and pain. The fact is that the one meal, after the previous rest of dressing, &c., is lightened by social intercourse, the other weighed down by the cares and worries of ordinary life. The remedy is an obvious one, and in their own power.

A very injurious habit to persons with inefficient gastric juice, is that of going for long periods without food, and then feeding largely. They avoid an early luncheon perhaps for convenience sake, and then take none later for fear of "spoiling their dinner." Now the best thing that can happen in their case to a heavy dinner, is to be "spoiled;" that is, for the unnaturally ravenous appetite to be stayed, and desire for a moderate useful meal only left. Five hours is the longest interval that should occur between the meals of weakly persons, or it is ten chances to one that they will eat too much at a time. As a general rule, let them remember always to *spoil their appetite.*

Among the too long intervals often left between meals, should be mentioned the night. Persons sit up late, and then go to bed with a wearied, undefinable sense of sinking, an irritable temper, and coldness of extremities, by which symptoms they are kept from sleep, and lie tossing about like invalids. These evils may be obviated by a light supper. Beef tea* I have often found an excellent prescription in such cases, or a plain biscuit, with a glass of wine and water. But others, either from inclination or idiosyncrasy, seem better suited with a cup of gruel on retiring to rest.

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* The solid beef tea, dried so as to keep an indefinite length of time, and used with a little hot water when wanted, is a most valuable preparation. But care should be taken that it is not made at too high a heat, otherwise it is little else but glue. The rich gravy-like odour is the best test of its goodness, and the best guarantee is to have it made by a tradesman you can thoroughly trust.

The want of a perfect balance between the income and expenditure of the tissues by assimilation, so that on any accidentally increased exertion in the cases we are considering there is apt to be greater destruction than is good for the frame, makes valuable any article of diet that will even temporarily limit the destruction, and enable more to be assimilated. Hence the importance to many persons in fair average health of the habitual daily use of one or other of those articles which were described in the First Book of this volume as "Accessory Food." For some tea or coffee is sufficient, but many really would not live to their natural term if the instinctive* craving for some form of alcohol were ungratified, and certainly without it would be obliged very much to abridge their powers of being useful in their generation.

Where anæmia is joined to gastric flux, ulcer, or other aliments, it is often a question whether you should risk making the anæmia worse by the spare diet and other treatment which is required to cure the stomach, or whether you should principally attend to the anæmia, and let renewed health assist you in the cure of the local aliment. A question indeed similar to this occurs in all chronic disorders, and it is one which, more than any other exercises the special judgment of the physician in each individual case.

In the case of the stomach, as a rule, I think it better first to attend principally to the local derangement, because till you can have a healthy or moderately healthy digestive organ as an assistant, you can do little towards a renewal of the blood; but when that aids you, the restoration of the vital stream goes on of its own accord. Indeed, the return to strength seems to take place even *in spite* of lowering measures. I mean, that while debilitating remedies are still in force, the weak blood becomes more and more healthy and strong. As, for instance, in a woman with probable gastric ulcer, under my care at the present moment, who is having leeches on every other night, the lips and tongue are gaining colour, and there is a weekly increase of several pounds in weight.

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* Is it not right to call the desire for alcohol "*instinctive*," when it is stated by the Editor of the *Band of Hope Review* (on the authority of the famous T—total lecturer, Mr. Gough), that of half a million of persons who had taken vows of abstinence in the United States, 350,000 broke them? truly an awful outburst of nature! Have the same proportion ever violated vows of chastity, or any other similar solemn obligation?

Where the retention of the gastric secretion is not balanced by some evacuation elsewhere, and so a gouty or rheumatic constitution is joined to weakness of digestion, we must keep in mind the necessity of not limiting too much or too continuously the destructive assimilation. There is in this case a difficult point to be compassed: to evacuate that which is morbidly retained, we must augment the moulting of the body; to prevent the destruction from exceeding the limited supply, we must adopt measures to diminish it. Yet it is clear that these two opposite courses cannot be at once pursued, and the question is, Whether we cannot obtain the advantages without the accompanying evils of either course carried *à l'outrance?*

The only way to do this is to imitate those politicians, who, following Lord Peterborough, prided themselves on the cognomen of "Trimmers"—we must sell ourselves to both parties. At one time destruction must be limited, while nutrition is necessarily sparing; and then for a time destruction must be encouraged, till that which is morbidly retained is washed away. A diet must be kept up containing all the complementary nutrition that the alimentary canal can manage to digest with its weak powers, and *in general* accessory foods which limit destruction must be taken as a habit; but *from time to time* these latter must be left off, and water, salt, laxative medicines, or alteratives, taken, to encourage that which as a habit is limited. In fact, instead of a constant drain on the system, the plan of occasionally flushing the sewers must be adopted.

A course of alkaline or neutral mineral waters is the oldest established mode of effecting this end, and when properly used there is none more efficient. From the thanks of the pagan Roman "NYMPHIS LOCI," dug up so frequently about Wiesbaden and Aix, to the faces, grateful it is to be hoped to a higher Power, seen there every summer, there is a continuous chain of acknowledgment of its benefits to those who have been limiting destruction by accessory food, and augmenting nutrition by full diet all the rest of the year.

The principal occasion of disappointment in the use of alkaline and saline springs, arises from injudicious excess in the employment of them. Patients conceive that some results, appreciable even by their uneducated senses, ought to follow the remedy; and hence they insist upon taking such a quantity as will purge, sweat, or diureticise them to a notable amount. In short, they insist upon the hurtful effects being visible, as a test that the good effects are really going on. Hence debility, and sometimes a consequent future increase of their disorder follows.

The best way of guarding against this incautious zeal is to point out rationally what is really intended by the remedy; to say that *we had rather it should not* produce any of the classified effects of drugs; and that what we want is an increase for a time of the interstitial destruction, which increase may take place without any of the inconveniently morbid results above named, and may be capable of scientific valuation and use without any of the familiar outward signs,—this explanation, if not understood by the patients, will at all events be appreciated by their medical attendants, and, it is to be hoped, acted upon.

The use of bitters and tonics require a good deal of discrimination. Where there is *anæmia*, especially with a tendency to mucous flux of any part, "iron alum," in doses of a grain or two three times a-day, is an admirable temporary remedy. *Loss of appetite* calls for light vegetable bitters, such as gentian, or red bark, or cascarilla. Where the deficient powers of gastric digestion are distinctly traceable to *mental labours* having exhausted the nervous energy, Linnæus' prescription of nux vomica is most valuable. The best mode of administering a remedy of which such a graduated dose is required, is in its alkaloid strychnine, of which one-twelfth of a grain may be given to a dose, in frequency proportioned to the circumstances or decided by experiment in each case. There is nothing which so well restores the digestive energy of persons whose brains are over-fagged. Where deficiency of gastric juice cannot be associated with any of the above-named pathological conditions, or where it is purely hereditary, bitters and tonics rarely agree, and must be tried with much caution.

SECTION VI.—*Degeneration of the Glands of the Stomach.*

Before entering upon a discussion of the special instance of the above-named condition which our subject requires, it will be worth while to collect into a few pages the scattered notions which constitute the present idea of degeneration. The whole process pathologists are not yet in a position to speak of. As we see it, it may be defined to imply certain alterations in the solids known by the absence of healthy matter, and the presence in its place and *in its form* of matter, organic indeed and organized, yet incapable of the due functions of that which it replaces It is not only a morbid deposit, but a morbid deposit *instead of a healthy one.* It may be said to involve two processes, the *imperfect growth of tissue*, and the *growth of imperfect tissue.*

Degeneration is, in point of fact, "atrophy," or a want of supply to the part of its proper τροφη, which is necessary to complete the true tissue; but "atrophy" has by long consent been restricted to cases where the weight and external size of an organ are diminished, and is not applied to those where the imperfect matter deposited equals or exceeds in amount that which is removed; although the ætiology of the two and their real natures are so similar, and although both conditions are often found in the same organ. If "atrophy" is to be applied to mere loss of size, and "hypertrophy" to mere increase of size, as was usual a few years ago, the distinction is unreal, unessential, and therefore unpractical, and I must utter a protest against it. If "hypertrophy" is to be restricted to augmentation of proper tissue (as in obesity or muscular growth), and "atrophy" to mean diminution of proper tissues, it expresses a useful fact; but then it would apply to some cases, where, though the proper tissue is lessened, the whole viscus is increased, and thus shock those who are used to the nomenclature of ten years ago. *Degeneration* is therefore the term least likely to be misunderstood.

The most striking and complete instance of a degeneration, is that of the bones, which constitutes the terrible disease Osteo-malacia, or softening of the bones. That firm fibrous structure which binds together the phosphate of lime throughout the skeleton, is no longer formed; but in its stead there grows a quantity of oil. Then the phosphate of lime passes away by absorption, so that in a short space of time, in the place of a solid stony pillar of bone, there remains only a model of it in fat.*

From such glaring instances, appreciable by the naked eye and naked hands, an impression may be gained of the nature of those degenerations which are discernible only by the microscope. Deaths from diseased heart frequently happen, where, at the examination after death, there seems to be not nearly enough mischief done to the organ to cause the catastrophe. But on placing the muscular fibre under a microscope, you find the form indeed pretty well preserved, and the quantity perfect; but the minute striæ which run across the ribands of fibrillæ are partially or wholly obliterated, and their place taken by tiny black specks, mixed with larger brilliant specks with a dark outline. We find also that by soaking it in æther, or by heating it on a peace of blotting paper, we can get evidence of there being an unnatural quantity of oil in the tissue. Hence we conclude, not unfairly, that these small black specks are what they look like, namely, finely-divided fat. This is the most familiar and striking instance that can be quoted of an interstitial change of substance, without change of form visible to the naked eye.

Equally with bone and muscle, and perhaps more commonly than either, glands become degenerated in structure without there being necessarily any appreciable aleration in form or weight. In the kidneys this constitutes that unfortunately frequent condition, Bright's disease, and is one of the most usual causes of albuminous urine and dropsy. It is not at all uncommon to find these organs presenting to the naked eye a normal appearance, while examination by the microscope reveals the fact that the structure necessary to secretion is deficient through the greater part of the gland, and is replaced by either a less organized fibroid, or by an albuminoid substance, or by fat. Sometimes this degeneration is confined to the epithelium which lines the tubes, where, instead of the healthy structure, there are seen granular masses, and frequently distinct oil globules, recognised by their highly refractive substance and clear dark outline. These coherent fibrinous or oily skins are thrown off from the tubes, aud form the delicate transparent threads found, with a moderately powerful glass, in albuminous urine, and well-named "casts."

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* See a "Sketch of the Microscopic Anatomy of Softened Bones," by the Author, in the *Medico-Chirurgical Transactions*, vol. xxxvii., p. 18.

I have mentioned above the three different forms which the morbid substitutes for healthy tissue may assume: viz., the FIBROID, ALBUMINOID, and FATTY.

The most familiar instance of an imperfect FIBROID tissue is a scar. A solid, white, tough organized substance takes the place of that which had been destroyed by an injury. It is unnecessary to describe what is so well known. Just in the same way, if a muscle is diseased, it becomes sometimes converted into an exact resemblance to the tendon which forms its extremity. So on serous membranes which ought to be transparent, such as the pericardium, you find white opaque patches. The delicate transparent membrane is removed, and a thick scar-like patch left in its place. So too, in glands, there goes on an analogous process. The liver becomes harder and heavier than natural, the interstices between the lobules become thicker and more solid, just in proportion as the secreting structure dwindles away. Hence the tissue is not so homogeneous as natural; it is collected into large grains, constituting what is called "granular liver," and by reason of its hardness receives from the Greek the title of "Cirrhosis." The kidneys become hard and white in a similar way, in one form of Bright's disease. And probably all other organs are liable to the same evil, those which I have mentioned being simply the most important, from their intimate connexion with the daily needs of life. Fibroid degenerate tissue is sometimes formed in greater quantity than what it replaces; and hence it is possible to have an increase of size and weight in the organ affected, while yet its ultimate tendency is to contract into itself, and to form hard, dwindled masses. This is strikingly exemplified in scars, especially in the dreadful disfigurements occasioned by contracting cicatrices of the skin in the neck: the lips and eyelids are dragged down by the stern, slow, fatal strength of the shrinking fibrous tissue, till the face is hardly recognisable as human. So the liver is usually shrunk up and dwindled by this deposit of fibrous tissue in its interstices, the edges are rounded, and the outside covered with wrinkles and irregular depressions; so too are the kidneys, they become hard, small, and covered with scars, while the capsule, which should be sufficiently loose to peel off easily, is bound by the contracting cellular tissue so close to the viscus, that you can scarcely detach it without tearing.

ALBUMINOID degeneration has not received so much investigation as the fibroid, but as a sort of recompence it has received a great variety of names. Portal and Abercrombie called it an albumin*ous* infiltration, which was assuming a little too much as to its nature; the French described it as *lardacée*, or "lard-like;" the Germans are *speckig*, or "bacon-like;" to neither of which is its resemblance very close. Dr. Gairdner calls it "waxy:" so we may see none of these pathologists are quite satisfied with one another's comparisons, all being in fact imperfect. Dr. Budd, with a boldness I cannot commend, calls it "scrofulous," from which it is certainly very different; and Mr. Prosecter Meckel has quite lately given it the name of "Cholesterine disease."* This variety of denominations shows that but little is known except that it is in a dense, colourless, homogeneous, translucent substance, more friable, and less tough than fibrin, and not possessed of the tendency to contract so strikingly distinctive of the latter. It is as like greasy coagulated albumen as anything else.

By this degeneration the affected organ is never contracted, and sometimes is very much enlarged, as in the not unfamiliar instances of the spleen and the liver.

The very large pale kidneys, with loosely adherent capsules, sometimes found in Bright's disease, are, I believe, instances of the same degeneration.

FATTY degeneration has already been used as an illustration of what was meant by the term degeneration, and was exemplified in several tissues. It is liable to occur after, and as a further stage of the other two kinds, but is not necessarily preceded by them. The heart may be quoted as an instance of this, where you may by the microscope detect the degeneration at such an early stage, it is certain that no other morbid condition has gone before.

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* See *Medico-Chirurgical Review*, Oct. 1854.

But though it may commence primarily, and indeed commences primarily more often than either of the other forms of degeneration, yet it is a greater departure from the state of healthy nature than either of them. Organic substances may be ranked according to the degree of physical life they are capable of being endowed with—according to the distance they are removed from the purely chemical reactions of inorganic matter. Thus, *Fibrin* alone is capable of entering into a direct intercourse with mind, of being the immediate agent of the will in voluntary motion: *Albumen* may be the recipient and retainer of life, as in the ovum and in plants, but is incapable of serving the soul by moving in obedience to it: *Fat* can do neither the one nor the other. Moreover, whilst fibrin and albumen both require life for their production, fat may be formed by their decomposition;—they *must* be products of life, it *may* be an educt of death. Thus we may artificially, in the laboratory, produce fat from muscle. The familiar instance of the formation of adipocire from buried corpses in the old cemetery which formerly covered the ground where the Marché des Innocents now is, first, through Fourcroy, drew modern* attention to the subject, and fixed attention by giving the substance a name. Just in the same way if a piece of muscle, such as a heart for instance, be exposed to a running stream for a few weeks, or placed in weak spirit and water, it becomes converted into fat, first exhibiting the granular form, and then putting on a regular waxy appearance. In a case where the fibrin of the blood was passed by the kidneys, constituting the spontaneously coagulable urine, I found no fat was extractable by ether, but on keeping the fluid for three months under a layer of ether, the whole of the coagulable fibrin was converted into oil, and dissolved in the supernatant menstruum.

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* It had not escaped the shrewd eyes of Sir Thomas Brown, who observes in his *Hydriotaphia*, "In an hydropical body, ten years buried in the churchyard, we met with a fat concretion, where the nitre of the earth and the salt and lixivious liquor of the body has coagulated large lumps of fat into the consistence of the hardest Castile soap." A quotation from Lord Bacon (*Silva Silvarum*, Exp. 678) sometimes referred to as bearing on this subject, has nothing to do with it, relating merely to the extraction of the fat diffused through waste flesh in a recent state, of which he purposes to make economical use.

The formation of fat then, as a process of degeneration, may be a species of decomposition. It may be a retention in the system of that effete substance which ought to be got rid of by interstitial absorption—a death or metamorphosis *in* the body, which ought to take place *out* of the body. It is not known whether it is so, or whether it is a deposit from the blood of fat instead of fibrin; but in either case it is a degeneration, the presence of a less vitalized tissue, instead of a higher and more vitalized one.

A practically correct, though metaphorical idea, therefore, of degeneration may be formed by representing it as a partial arrest of metamorphosis; a state of the solid tissues in which the phenomena of life are exhibited in too feeble a degree for the production of the type of those tissues. In the liver, instead of a definitely formed congeries of cells, there is an indefinite growth of fibrin, disposed to contract and follow the general laws of fibrin, or perhaps an albuminous infiltration, still less capable of active life; while, at the same time, the secreting cells, instead of doing their proper work, become converted into oil. Similar changes may happen in the placenta; in the eye, forming "arcus senilis," &c.

As in degeneration indefinitely-shaped fibrin is formed in the tissues, and as an inflammation indefinitely-shaped fibrin is also thrown out, and fibrin then also exists in excess in the blood, the two processes have been likened to each other; and the one at present under description has been disposed of as a sort of "inflammation." But how different the vital phenomena of these almost contrasted processes! Watch degeneration where you have an opportunity of watching so well all physiological acts, in the transparent eye. If arcus senilis, as degeneration of the cornea is called, was accompanied or preceded by congestion, heat, swelling, and pain, such facts could not escape notice: there is notoriously nothing of the sort. If Bright's disease of the kidneys began by inflammatory symptoms, we should not be left long doubting about the fact. True, there is sometimes hæmaturia at the commencement, but certainly not as a rule, and that hæmaturia is not of an active sort. There is no pain or fever, as in renal inflammation. Then again, degeneration attacks principally those parts which are least liable to inflammation, such as the kidneys,* and avoids those which are most liable, such as lungs, areolar tissue, and skin. It is surely a pity to use any common term for such very different things.

It was not to be expected that the glandular coat of the stomach should escape a misfortune which happens to almost every other part of the body. Its degeneration, however, has not attracted the same amount of notice as that of other organs. MM. Engel and Wedl† have cursorily alluded to it, and Dr. Handfield Jones‡ has published the *consecutive*§ examinations of 100 stomachs, in many of which this degeneration was to be found, but I doubt if any other pathologists have investigated it. The accuracy of the descriptions of the latter gentleman I can testify to, having examined at the same time with him several of the cases which were patients of my own. I therefore borrow with confidence from his paper in the *Medico-Chirurgical Transactions*, and have used it in drawing up the subjoined classification.

The mucous membrane of the stomach presents the following distinct forms (or degrees in extent) of degeneration, named as they appear to the eye, and explained by the microscope:—

1. *Thinning; i.e.*, destruction of the tubular or glandular structure, without the formation of so much in its place as is

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* See statistical evidence of the familiar fact of the variety of inflammation in the kidneys, and their power of resistance to it, in the "Decennium Pathologicum" of the present author, in the *Medico-Chirurgical Review*, April, 1853.

† *Grundzuge der Pathologischen Histologie*, p. 185.

‡ *Medico-Chirurgical Transactions*, vol. xxxvii, p. 87.

§ It is very necessary to place some guard over that weakness of our minds which causes positive events to take a much firmer hold on the memory than negative ones, which allows the seeing a thing a few times to outweigh the hundred times we do not see it under similar circumstances, and consequently causes false inferences to be drawn. With the intention of placing such a check on the fancy, I think it always desirable to select cases, if possible, from a definite number taken *consecutively*, and to let that definite number be the whole that have come under notice during a certain period. We shall thus get a fair notion of the real frequency or rarity of the phenomena we are observing, and of their consequent importance; and we shall have a source of statistical information, scanty perhaps, but ten times the worth of a collection of facts made sporadically, or with the view of proving a predetermined point.

removed; so that if a quantity of granular *débris* did not remain, it would seem like a simple removal of the gland tissue.

2. *Mammillation;* so called from the lumpy islands which rise up on the surface of the stomach, like "*mammæ*"—(they are not *very* like.) It is in fact a reticulated veining of partial atrophy or degeneration, which leaves insulated portions either of their original thickness, or else with a deposit of fibrous matter in them—a state of things, as Dr. Jones well observes, closely analogous to the granulations of Bright's kidneys.

3. *Equal Thickening throughout; i.e.,* a removal of healthy tissue, but a deposit of a greater amount of morbid or less organized matter, so as to add to the sum total of the viscus.

4. Degeneration of the atrophied masses into *fat vesicles and fatty matter.*

These are the best marked differences between the several appearances presented, but there are besides other accidental circumstances which occasion apparent varieties. Thus we find in many of them black pigment, which is the *débris* of altered hæmatin, showing that congestion had formerly existed in the part; and small dark-red specks of obstructed capillaries where it is more recent. By these means several variations in colouring arise. The formation of cysts in the stroma of the mucous membrane, the partial distortion of the tubular glands, are accidental occurrences in all the forms; and sometimes the distortion causes the tubes to mass together into lumps, almost like conglomerate glands, especially in the pyloric region.

Now the above-named appearances are just the same as are found in all degenerated glands, and are most familiar to us in those easiest examined—the kidneys. We do not there set them down as the causes of the degeneration, nor consider them as forming the essence of the state, and are naturally led to the same conclusion in the stomach likewise.

The frequency of degeneration of the glandular structure of the stomach is very great: in the 100 cases collected by Dr. Jones, no less than 77 of the stomachs exhibited this form of atrophy, more or less, and in 14 of these the destruction of tubes was very great. We may say that 23 per cent. were in perfect condition; 63 not likely seriously to interfere with health, and 14 unequal to their required duties.*

The prevalence of degeneration as a disease of the kidneys, I showed in the "Decennium Pathologicum," where it was seen to be probable that one-fifth of those who die in the humbler ranks of life have this lesion; for in 2161 autopsies there were 454, or 21 per cent., visibly thus affected.†

It is impossible to draw a comparison between these numbers, because the descriptions are not made by the same observer, and consequently the line of demarcation between health and disease is not drawn in the same place.

But whichever set of numbers we look at, we cannot but be struck with the strong tendency to glandular degeneration exhibited by chronic patients in the present day. We cannot tell whether the same existed in former times, for our predecessors had not the same facilities of observation and record that we have; but changes in the modes of practice generally found curative would seem to indicate that a change has taken place in the human constitution, as well as in minds and manners. The increased intolerance of bleeding and other depletory measures, exhibited by the sick, however afflicted, is matter of daily observation. If we were to follow our grandfathers' prescriptions, few patients would survive. It is an interesting question which now a steady perseverance in statistical records may solve, whether this tendency is strengthening in us, whether the race of man, as it grows older, becomes more subject to an organic lesion which, as we shall shortly see, is peculiarly one of advancing years? Is the change due to external circumstances merely, to varied habits and manners, to any cyclical revolution of planetary and terrestrial phenomena as yet unobserved?—or shall we seek it in the body itself, and trace in the physical differences continuously augmented by transmission from sire to son the alteration of the race?‡

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* Total in Dr. Jones' tables, *Medico-Chirurgical Transactions*, vol. xxxvii. p. 109. In his own reckoning, p. 101, he has omitted five as "nearly healthy."

† *Medico-Chirurgical Review* for April, 1853, p. 503, and the corrected copy of the "Decennium Pathologicum" in the library of the Medico-Chirurgical Society, p. 112.

‡ I made these remarks in the "Decennium Pathologicum" about the kidneys, but they apply equally to all sorts of degeneration.

I have been careful in the above sentences to say "change," and not "deterioration," because the records of insurance show arithmetically, as far as length of days is concerned, we need not be afraid that we are "*daturi progeniem vitiosiorem.*" The getting rid of the many fatal worms in the bud of human life, which our generation has to rejoice in, may well compensate for the possible increase of others less quickly destructive. We have only to be forewarned and forearmed against the latter to conduct our race to the highest state of physical condition it is capable of.

It has been already mentioned, that the tendency to degeneration increases with advancing years. This is very strikingly shown in the kidneys. In the "Decennium Pathologicum" I have published the following statistics of the 2161 cases examined:—

Under the	age of	15	in every hundred	5·8	had Bright's disease
Between	„	15 and 30	„	13·3	„
„	„	30 and 45	„	22·8	„
„	„	45 and 60	„	31·0	„
Above	„	60	„	34·1	„

The same result concerning the stomach is deducible from Dr. Jones's paper. Of the 77 cases he details—

7	were	under	20	years of age.
13	„	between	20 and 30	„
11	„	„	30 and 40	„
17	„	„	40 and 50	„
10	„	„	50 and 60	„
19	„	above	60	„

Of the *causes* of degeneration as a whole, and of those of degeneration of the stomach in particular, we have not yet sufficient evidence to say much. The prevalence of this form of organic change, as exemplified most familiarly in the kidneys, greater under temperate than under hot climates, and among the uncomfortable classes than among those who have the power of avoiding noxious influences, seems to point to the effects of cold and damp on the skin, joined to the want of those comforts which are agreeable to the body, as the chief agents in its production. But beyond this and the influence of age, I fear little can be stated positively.

Some influences that moral prepossessions might have induced us to expect would act in the production of this lesion in the stomach, do not seem to have much to do with it. The 11 cases of hard drinkers collected by Dr. Jones, had, as a rule, less the matter with their gastric glands than the temperate. In only three was the amount of destruction very extensive; and in one man whose addiction to the vice was so great as to sink him materially in the social scale, and cause his death in an hospital at forty-nine, of diseased heart and liver, there was unexpectedly found a very tolerable state of stomach;—not more disease in fact than was observed in numerous patients whose lives had certainly been very unlike his.

I have not details as to the mode of life of a set of cases of diseased kidneys sufficiently complete for statistical purposes, but certainly my impression, derived from hospital experience is, that in the case of the degeneration of these glands also, alcohol cannot be regarded as a direct agent. Intemperate classes, such as tailors, prostitutes, beggars, thieves, &c., do not seem to suffer in a greater proportion than other persons equally exposed to wind and weather or bad air.

The *symptoms* of degeneration of the gastric glands are much more of a negative than of a positive character: the lesion is but little, if at all, marked by any sensations in the stomach itself. This is just what we might expect from the phenomena of the analogous condition in other organs. We do not discover Bright's kidneys from the feelings of the loins, or fatty hearts from pain in the cardiac region; even softening of the bones itself produces no pain in the yielding skeleton till actual fracture takes pace.

It is only when the glandular layer is utterly destroyed that gastric symptoms, specially so called, are produced. This was the case in a respectable sober bricklayer, aged about fifty, whom I was requested to see by Mr. Ancell. He had been for years troubled with vomiting, generally occurring an hour or two after a meal, preceded by a sense of weight, without pain, in the epigastrium. Latterly he had been unable to keep any solid food on his stomach, and but little liquid, and was reduced to a state of extreme emaciation and anæmia. Examination and pressure even were borne without pain. He had been treated by a variety of physicians with occasionally temporary, but never lasting, benefit. However, what seemed to have done him most good were blisters and gentle mercurials, at an earlier period of the complaint.

Death here certainly followed directly on the disordered functions of the stomach. That organ was found *post-mortem* (as reported by Dr. Jones) with scarce a trace of tubular structure. There was no disease of importance in the other viscera.

But on the other hand, cases of extreme degeneration are quoted by Dr. Jones, in which no more stomach symptoms appeared than in others with the tubular structure almost healthy. And one case is more fully detailed, in which the absence of any previous epigastric pain, or special habits relating to food or emaciation, was particularly noticed, though the tubes in the middle and pyloric regions were entirely wasted.*

Probably the reason for the presence or absence of gastric symptoms lies not so much in the *degree* of degeneration, as in the *extent;* and future investigation may be expected to show that the local phenomena predominate in proportion to the superficial amount of lesion in the mucous membrane, and not the degeneracy of the tissue. It is indeed not unfair to suppose that so long as any gastric glands remain in a good working condition, they may respond to the call for increased exertion made by their disabled colleagues, just as one kidney or one lung often does duty for two. But when all are equally unfitted for work, continuously increasing deficiency of the solvent secretion must arise.

These cases, however, are not without some obscure negative phenomena. There is a want of power to resist injuries generally unimportant, with a disappointing inability to profit by nutriments, stimulants, or drugs, at least in a degree proportioned to the dose, and alarming symptoms supervene much sooner than was to have been expected. These are the cases which disappoint friends so much by not "rallying" when the illness has in truth been slight, and which, if not understood, shake so sadly the faith of believers in the sole power of the pharmacopœia.

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* Jones *On the Stomach*, p. 106.

Where such evidences, otherwise inexplicable, exist of the imperfection of one of the main aids to the conveyance into the system of the nutriment proper for its renewal, we may conjecture the existence of the lesion in question, and modify accordingly the management of the present diseases and of the future life of the patient.

The prognosis of degenerate stomachs, when we are enabled to suspect their existence, hangs solely on the superficial extent of the injury. For, as before said, probably on the superficial extent depends the prominence of the lesed functions of life. Diagnosis therefore, even if it could make it more certain, would not alone help to prognosticate the event. By the degree of emaciation, anæmia, debility, and want of vital elasticity alone, whatever they depend on, can we judge of the gravity of the case before us.

Remarks on Treatment.

I am far from regarding degeneration as an inevitable evil, whose advances we have got to watch and deplore without raising a hand against them. Possibly we cannot restore the destroyed tissue (though as long as the form is preserved I am not sure of that), but we can at any rate try to check the destruction of that which remains intact. What have we? An arrest of metamorphosis; old tissue is not removed, and new tissue not formed to put in its place. Doubtless, then, our business is to adopt such measures as liquify and remove effete matters, and augment the efficiency of the blood to form new. Try this plan in degeneration of the kidneys, where we can test the advance or recession of the morbid state by the urine and general health. In Bright's disease I know of no treatment so advantageous as that which unites alteratives (that is, liquefacients of tissue) with those restorers of blood *par excellence*, iron and animal food: and the patients have benefited just in proportion as I have been enabled by circumstances to carry out the administration of alteratives without producing their poisonous effects. Those derive most advantage who are able to continue taking blue pill nightly without salivation, those next who can take corrosive sublimate, those next who can only bear neutral salts, iodide of potassium, and water in bath and beverage. Under all circumstances iron has been most efficacious when given at the same time as the mercury, salines, and water; and when animal food has been enabled to be digested, so as apparently to supply the renewing plasma at the same time as the old is removed.

This "renewal of age," as the Hebrew Psalmist would term it, cannot but be equally applicable to one form of degeneration as another, only that in gastric degeneration one would be careful to select mercurials which specially act upon the stomach, such as corrosive sublimate, whose poisonous effects we know to be chiefly manifested in that organ, and therefore may conjecture that the medicinal effects follow the same rule. And the animal food one would be careful to administer in small frequent quantities knowing the deficiency which there must be of gastric juice.

The knowledge that the solvent powers of the stomach decline as age advances, suggests that elderly people should gradually diminish the quantity of food taken at a meal, especially of animal food. If the system requires it, they may eat oftener than before, but less at a time, and be more careful than ever not to waste the power they have on indigestible useless matter. There is great good sense in an aphorism of Dr. Cheyne's:

"Aph. 13. Every wise man after fifty, ought to begin to lessen at least the quantity of his aliment; and if he would continue free of great and dangerous distempers, and preserve his senses and faculties clear to the last, he ought every seven years to go on abating gradually and sensibly, and at last descend out of life as he ascended into it, even into the child's diet.*

Vinum lac senum, is an old saying which is the result of an universal experience. It may at first glance appear inconsistent with the above-quoted dictum, yet in reality it is not so. The stimulus of alcohol enables the weak stomach (or in other words, the small remnant glandular structure left to the aged body) to do extra duty for a time, and digest that which would otherwise be useless; so that though the quantity with which the organ is loaded may be diminished in obedience to our aphorism, yet by getting the utmost benefit out of that quantity, the necessary supply of nutriment may be kept up. The proper limitations of *use* and *abuse* will be discussed in a future chapter.*

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* Cheyne, *On Regimen*. London, 1740.

SECTION VII.—*Ulcer of Stomach.*

Ulcer of the stomach is an actual loss of substance over a greater or less extent of the mucous membrane. The tissue is absolutely destroyed, and replaced by nothing.

It is a much more dangerous disease than degeneration, and may prove fatal in several ways:—

First.—It may perforate right through the serous sac, and destroy by peritonitis.

Secondly.—It may open into a large bloodvessel, and cause hæmorrhage.

Thirdly.—It may exhaust the vital energies, by vomiting and marasmus.

The first mode is the most common among the young, the second and third among the middle aged and elderly.

Rapidly perforating ulceration has been so often found in young females, that it has, unnecessarily I think, been held to constitute a separate sort of ulcer, called *par excellence*, "*the* perforating ulcer." The greater frequency of this termination in youth is probably due to the greater rapidity of all vital processes at that age, and perhaps, also, something is to be attributed to the greater activity and quantity of the gastric juice.

The same tendency to strike deep and perforate, exhibited by ulcers in youth, is equally seen in ulcerations of other parts of the intestinal canal besides the stomach, and moreover appears quite independent of the disease which has given rise to the ulceration; it is the young and vigorous whose intestines become perforated, whether the first origin of the evil was pulmonary consumption, dysentery, fever, or chronic inflammation. This fact is proved by the same decennial collection of 2161 *post-mortem* examinations at St. George's Hospital, which I before quoted.* In 128 of these, various parts of the intestines, not including the rectum, were ulcerated, in connexion with tubercular disease in the lungs; and in 9 of the 128, perforation had taken place. The ages of the 9 were as follows, placed in order of their youth; namely, 15, 17, 22, 22, 25, 29, 33, 34, and one young man of age unknown. In eighty other cases, non-malignant ulceration had occurred from various causes, chronic and acute,† independent of tuberculosis; and perforation had occurred in several parts (exclusive of the rectum) in sixteen instances, as a consequence of the extension of the ulcer outwards.‡ The ages of these sixteen patients were, 7, 16, 16, 16, 20, 21, 22, 24, 24, 28, 30, 30, 30, 35, 37, 56. These examples suffice to show exactly the same fact as our table of ulcerations of the stomach; namely, that *all* ulcers tend to penetrate the peritoneum more in youth than in declining years, but that such a tendency is not by any means confined to one period of life, nor to one peculiar species of ulcer.

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* Chapter x. § 4.

If the ulceration has existed but a short time, as in the so-called "perforating ulcer" of youth, then the edges are sharp, as if a hole had been punched out of the membrane. Sometimes these "punched holes" extend right through the stomach, constituting perforations; sometimes they are in the mucous coat only. The last was the case in five instances of ulcers not in themselves fatal, and in one of ulcer fatal by the exhaustion of vomiting, cited in a paper on this subject by the present author (*London Journal of Medicine*, July, 1852); and in another instance related in Dr. Bristow's words in the *Medico-Chirurgical Transactions*, vol. xxxvii., p. 98; and in three of Dr. Jones's cases. Three instances of punched *perforation* may be found in the above-quoted paper by the author, and in most books on morbid anatomy.

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* I must take this opportunity of thanking the present medical staff of St. George's for permission to arrange and publish the information, so valuable in a statistical point of view, contained in their well-kept record of fatal cases.

† Cases of typhoid fever are fairly included, because, though the primary solution of continuity in the intestines is of the nature of slough, yet the perforation of the peritoneum is the consequence of ulceration following that slough, and occurs usually after the fever is gone.

‡ This latter clause is to exclude cases of perforation from injury and from external causes, as *e.g.*, from a gall-stone eating its way into the duodenum.

On the other hand, when it has lasted some time the edges of the ulcer are thick and raised, and the membrane around thickened also. Those ulcers with thickened edges perforate too, and occur in youth too (there are three cases of their having perforated, and three cases of their occurrence under five-and-twenty, in the above-quoted paper by the author); so that in fact they appear to be in no wise different from the thin-edged ulcer, except in having lasted longer time.

The most common situation for ulcers is in the lesser curve of the viscus, and they are more usually near the pylorus than the cardia.

Is ulceration of the stomach an idiopathic lesion, or is it a proof merely of the existence of some other morbid state? Now, if it is found constantly, or even frequently, associated with a certain class of diseases in life, or unnatural appearances after death, we might be led, even by the small number of examples before us, to put them together as cause and effect. But the evidence we have seems to show the reverse; for if we examine the collected cases we shall see that the concomitant degenerations of the viscera are so various, and in so many cases, where the accidents arising from the local disease have proved fatal, are the other organs quite healthy, that I think we may fairly consider ulceration of the stomach as always an independent disorder, and not a symptom or a consequence of other affections.

It is a common observation, that ulceration of the stomach is more common among females than males. This is quite borne out by the fact that seven out of ten persons under thirty years of age, mentioned in the paper by the present author, above quoted,* were of the former sex. The difference in the proportionate frequency with which the sexes are attacked, is not however sufficiently exclusive to lead to the supposition that it arises from any mysterious connexion between the stomach and those organs which distinguish man from woman. I should prefer attributing it to those habits of half-civilized life which females, voluntarily or involuntarily, persist in: such as wearing ill-fitting stays, with rigid beams in front pressing upon the viscera, leaning forward to work immediately after food, swallowing their meals half-masticated, keeping decayed teeth in their heads, allowing mental emotion to check digestion, and a variety of other similar causes of the difficulties into which their stomachs fall.

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* *London Journal of Medicine*, July, 1852.

It may be remarked, that perforation at least, and therefore probably ulceration of other parts of the intestinal canal, seems very impartial in its choice of sex. Among the nine cases mentioned above,* connected with tuberculosis, there were seven males and two females; and of the sixteen arising from other various causes seven were males and nine females.

It may interest some to compare the chances of perforation from simple ulcer, and from malignant disease of the stomach. In the decennial period at St. George's Hospital, ending Dec. 31st, 1850, there died thirty-four cases of malignant disease of the organ, and in these perforation occurred thrice; there were nineteen cases of simple ulcer, and perforation was found in nine of these. The difference is sufficiently marked to make the smallness of the numbers of no importance.

Perforation therefore is the most natural end of ulceration of the stomach, if it runs its full course. And what a fearful end! I protest that, when treating cases where ulcer of the stomach is likely, I have shuddered at the thought that there is possibly but a piece of gold-beater's skin between the invalid and death.

Besides perforation, another very intelligible danger consists in the liability of the bloodvessels to be eaten into. Hæmorrhage is very common, and in two cases which I have quoted in the *London Journal of Medicine*, it proved fatal from the large size of the artery opened. In one, curiously enough, it was fatal without hæmatemesis, the bleeding being wholly internal, and no blood vomited. Such a case however is rare, and bloody vomiting is certainly the rule in long-continued ulceration which penetrates bloodvessels.

Under what circumstances excessive vomiting and emaciation prove fatal in simple ulcer, I am unable to say. Such however was the end of two cases out of the twenty-two quoted as above mentioned.

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* p. 323.

What, now, are the symptoms of ulcer in the stomach? I mean the symptoms uncomplicated with any of those destructive accidents to which I have said it may give rise?

In the paper quoted from the *London Journal of Medicine*, I have collected nine instances of ulceration which did not in itself prove fatal, but where death occurred from other causes; eight from the *post-mortem* books of St. George's Hospital, and one from St. Mary's; and Dr. Jones adds six more cases of non-fatal ulceration in his already-quoted paper. In three of these fifteen cases, it is especially noted in the records that there were no local symptoms referable to the stomach, and in the others, none were prominent enough to attract the attention of those in charge of the sick, except indeed that one had a pain in the left hypochondrium (which, by-the-by, was *not* the situation of the ulcer), and a fanciful appetite, preferring rice to potatoes; but no vomiting, pyrosis, or any other mark of aggravated dyspepsia. Nor indeed does the long history present a record of more marked symptoms in cases where the consequences of the ulceration have been fatal.

There may be several explanations given of this absence of local phenomena. First, that where other diseases of a more painful nature exist, the less may be masked by the greater; as, for example, when we are having a tooth drawn we do not feel the dentist treading on our toe. Or it is possible that the confinement to bed, and the restricted diet imposed on the patient by the more important diseases of which people usually die, may tend to heal up ulcers of the mucous membrane, and so render its morbid states a greater rarity to the pathologist than to the practitioner. So we see it in a mucous membrane visible to the eye; abraded, and even ulcerated sore throats, constitute an appreciable fraction of our annual practice; yet I find that, in the 2161 *post-mortem* examinations made at St. George's in ten years, the pharynx was found reddened by inflammation only thirteen times, and ulcerated six times, and the tonsils ulcerated but eight times. So, too, the pharynx of a young woman, a patient of mine at St. Mary's for ulcerated œsophagus, presented, three weeks before death, a decided abrasion, which on *post-mortem* examination was not to be seen. Or it may be that the want of common sensibility in the organ touched makes it irresponsive to our modes of examination. I am inclined to attach much importance to this last explanation: and for this reason, that where pain does exist, it seldom points out the exact locality of the injury, being referred in several cases to the left hypochondrium, when the ulcers were found after death in a different situation. It is very probable that disordered sensations, proceeding from the mucous membrane of the stomach, are felt only at its outlets, in an analogous manner as irritation of the colon is felt principally at the anus, of the bronchi at the glottis. The same however does not happen where the peritoneal covering or the cellular tissue of the organ is involved, as in malignant disease or peritonitis; the pain proceeding from which usually denotes truly the locality of the lesion.

The pain felt after eating or drinking, in cases of ulceration of the stomach, is most marked when the aliments are of higher temperature than the body. Very often they can be borne when of low temperature—as for instance, iced milk or the like—while they give intense suffering if above 90°, that is to say, at all equal to the natural warmth of the stomach.

It is also much increased by moving about after meals, indeed to persons with ulceration of the stomach, absolute rest after eating is a matter of necessity.

The interval between the time when the food or other excitement is taken and the commencement of the pain, is not invariable. As a general rule, it begins within a quarter of an hour, but I have known it delayed much longer. Sometimes it gives no trouble so long as the meal goes on, and on its ceasing supervenes gradually, and attains its maximum in about five minutes. In fact, it closely resembles a toothache from an exposed nerve, which as we all know, will sometimes begin immediately when touched, but sometimes delays till mastication, or whatever else has roused it, is over.

The pain of an ulcer in the stomach is always increased by pressure, especially the local pressure of one or two fingers. Sometimes it is so mild when the patient is at rest, and so immediate when the parts are touched, that it may rather be called tenderness. This symptom, when present, I think is more peculiar to gastric ulcers than any other subjective phenomenon.

The continuance of the pain as a symptom is very variable. Sometimes it will be very bad indeed for days or weeks, and then again suddenly cease, so that food can be borne without any serious inconvenience. This is so similar to what happens in toothache from decay, that I cannot but think the pathology in the two cases is the same. It appears not unlikely that in ulceration, as in toothache, the pain arises from the exposure of many fine filaments of nerves in an open sore; when then, on the further progress of the destruction, the whole branch of the nerve is killed, we know that in the tooth, and may conjecture that in erosion of the stomach, sensation will cease.

The above-mentioned variability of the pain, where it exists, may serve with other signs to distinguish simple ulcer from malignant tumours, with or without a sore place. In the latter case the pain, though not always severe, yet when once it has begun, is almost always constant.

The appetite is rarely diminished, usually natural, and sometimes even craving. The latter is especially the case during the paroxysms of pain, and adds much to the distress of the patient and the difficulty of management.

Constipation is not uncommon, probably as a consequence of the irritability of the abdominal nerves transmitted from the sore place to the lower part of the intestinal canal. This should be borne in mind, that in diagnosis and treatment the symptom should be referred to its right source, and not reckoned as the cause of the concomitant evils.

Vomiting is a frequent, but by no means distinctive, accompaniment of gastric ulceration. It may be severe, yea, so severe as to cause death (as in the two cases quoted above from the *London Journal of Medicine*), but ordinarily it is only occasional, and the accesses not of long duration. It is of great importance to watch it closely, for where ulceration is really the cause of it, streaks of blood will seldom fail to be found some time or another, and in many cases more considerable ejection of blood occurs. These streaks of blood are of the highest value in a diagnostic point of view, because they are extremely rare in other diseases which may be mistaken for simple ulcer. In cancer, for instance, without ulcer (where the interference with digestion, though rare, is, when it does occur, not dissimilar from that which is felt in simple ulcer), hæmatemesis never supervenes; nor does it in mucous flux and in neuralgia, which the pain might cause to be mistaken for ulcer.

The blood is not always vomited; sometimes it is transmitted downwards with the food, and then, if in large quantities, may appear in the stools, blackened generally, and perhaps in lumps. But the microscope can always detect in it either natural or altered blood-disks.

In short, we may pronounce that the most distinctive and best marked symptom of ulceration is hæmorrhage in some form; if we find blood frequently vomited, either pure and red, or blackened by the gastric juice, or passed by the bowels, without any sign of intestinal lesion, and blackened as aforesaid by the gastric juice, we may be pretty certain there is an ulcer; and if there is at the same time pain after food, especially hot food, and after exercise and on pressure of the epigastrium in one local spot, our suspicions may be further strengthened.

But we must not be too certain of the absence of an ulcer from the absence of these symptoms, remembering in how many cases they are absent, and in how many they are masked by others. There is perhaps no lesion in the whole circle of pathology which more often escapes detection than ulceration of the stomach.

The *causes* of a disease are worth investigating, principally by reason of the hints thus gained for its treatment; and it is with this intention that the subject is here considered. The first point in the etiology to be made out for our guidance is, whether these ulcers are due to over-work of the stomach or under-work, whether they arise in those who eat too much or in those who eat too little; for upon this depends that main part of the patient's discipline, the nature of the diet. Now all the cases of ulceration I have been able to hear of, have been found in persons whose vital powers were at a low ebb. The hospital patients I have quoted were old housewives, exhausted by large families and hard labour, maids of all-work, servants out of place, paupers, vagabonds, and the like; and in the upper classes I only know of two *post-mortem* examinations where ulcer was identified, viz., in a leuco-phlegmatic Oxford Professor, and a weakly old lady. In fact, it seems to be a manifestation of deficient supply for the renewal of the part, and to be analogous to certain other ulcerations which take place in a cachectic state of body. The quick destruction of a thin-edged perforating ulcer may be compared to the rapid loss of substance in the "*cancrum oris*" of children, or the ulcerated cornea of starvation and arrested innervation; the old ulcer of slower growth is like the sore legs of our workhouse population, with their thick edges and copious deposit of fibrin. All are equally proofs of deficient nutriment.

Besides this, I am not able to assign any cause for ulceration, for some not uncommonly set down as such have, I think, rather evidence against them than for them. For instance, *interal abrasion* by hard substances is rendered unlikely by the usual situation of the ulcers near the pylorus; for such extraneous agents would surely act most powerfully at their first entrance, while fresh and sharp.*

External pressure would make ulcerated stomachs common among handicrafts where the epigastrium is subject to constant pressure, as with boot-makers. I am assured, however, by Mr. Sparks Hall, the boot-maker of Regent-street, that hæmatemesis, vomiting, and other signs of ulcer, are not known among his workmen, and that numerous as are the cases of injured digestion in consequence of the faulty habit of pressing the work against the epigastrium, none appear to take the form of gastric ulceration; the functions most commonly interfered with being those of the small intestines and colon and the peristaltic muscles.

Over-loading the stomach, were it a cause of ulceration, would render the lesion most common where it is never found, viz., among children; whereas the people where we find it are just those who do not over-load their stomachs.

Spirit-drinking, again, is an agent which moral considerations, probably, have got classed among the causes of ulceration of the stomach; for certainly, if we had to declare one way or the other, hospital experience would lead to the opinion that, so long as he can get a supply of liquor, it rather exempts the indulger than subjects him to this lesion.

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* How much hard rubbing the stomach will bear without ulcerating, is shown by an instance given in Dr. Baillie's *Morbid Anatomy*, of five half-penny pieces being retained in the stomach long enough to form a pouch, without any abrasion of surface.—Baillie's *Morbid Anatomy*, p. 92.

Remarks on Treatment.

The famous anatomist, M. Beclard, declared he had got an ulcer in his stomach. He persisted in living on spoon food till he felt well of the peculiar symptoms that had led him to this conclusion, and truly enough, after his death the cicatrix of an ulcer was found. So he was proved right in his diagnosis and successful in his treatment. From hence it has been inferred, wrongly I think, that the lowest diet consistent with life is the type of treatment which we should aim at attaining to in ulcerated stomach, and that the nearer we approach this the more likely the cure of the patient. But that is to misinterpret the experience set before us. What is really required is an avoidance of an over-load to the organ, and avoidance of everything which may distend and cause sanguineous congestion, while at the same time good nutriment is supplied. I do not know anything that accomplishes this purpose better than iced milk, with the addition of from one-quarter to one-third of lime water. A constant taking from time to time of two or three tablespoonfuls of this mixture renders regular meals unnecessary, for as much as a couple of quarts may easily be digested in the day. The solid food least injurious is captain's biscuit, well soaked in water, and made palatable by the addition of a little milk, guarded with soda, or else macaroni rendered exceedingly soft by long maceration and boiling.

Condiments in general should be eschewed. None seem to give so much pain as that apparently simplest and mildest of all —sugar. The nerves in all sore places are peculiarly sensitive to the action of this substance; tender gums and carious teeth, for instance, are pained by it more than even by salt, vinegar, or other soluble agents, and feel the pain too, so immediately that it cannot be due to any chemical change in the sugar. Those who have any ulcers in the digestive mucous membrane should as cautiously avoid it as those with tender teeth.

Such very great benefit accrues from this plan, both in ulceration and in other diseases of the stomach resembling it in symptoms, that it is seldom requisite to persevere in the extreme strictness of diet for above six or seven days, after which a gradual return to more ordinary food should be commenced.

Next to this mode of diet come leeches, as a most powerful means of preventing local congestion, of getting rid of the effete venous, and inducing a passage of fresh arterial blood through the capillaries of the neighbourhood. Applied three at a time about twice a week, they certainly do not weaken the patient, for weight will almost always found to be gained during their use. I cannot say that I have found blistering at all capable of supplying their place, though that has been often recommended by other practitioners.

Trisnitrate of bismuth gives much temporary relief, and I am inclined to think is of real value in healing the ulcer. It seems to have this effect also in ulcers of the lower part of the alimentary canal, and *à fortiori* benefit may be expected in the upper part, where the drug has better opportunities of getting to the sore place. But it must be administered in large doses of from fifteen to twenty grains, or no advantage follows, and may freely be increased to two scruples or a drachm, if necessary.

Astringents are often of signal benefit. Amongst them I should assign the first place to the newly-discovered salts of metals whose constitution and form are the same as alum, especially to "iron alum." Three or four grains of this salt taken thrice a day give an immediate relief to the pain; and the medicine has also the advantage of adding to the blood a metallic constituent, usually much required in these cases, and improving the anæmic condition.

As a change, gallic acid, nitric acid, and bitter barks may be employed; and in these cases, as in external ulcers, I have found great benefit from variety. The original medicine is often much more efficacious after a few days' change to another.

Nitrate of silver, given as usual in pills by itself, has disappointed me in the treatment of suspected ulcer, and indeed in all gastric complaints, though from its beneficial action in cases where it can be directly applied—as to the external skin and visible mucous membrane—it is a promising medicine. Probably it is converted into the inert chloride of silver before it arrives at the scene of action.*

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* It is possible by covering the pill with gelatine to delay somewhat this conversion of the nitrate; but the quantity of saline fluid it meets with immediately it is dissolved, seems to render it inert, unless given in larger quantities than is quite safe.

It is very possible that mere diet alone might cure ulcer of the stomach, but it is very desirable not to be obliged to trust solely to a measure which often would reduce too much the patient's strength. The blunting of the sensibility of the sore surface by medicine enables us sooner to return to hitherto unborne articles of food than had drugs not been used, and thus much to shorten the convalescence, which, in the case of the labouring classes, is a matter of great importance.

In all lesions of the stomach, the state of the mind has a more powerful influence over the progress of the morbid process, than when it is situated in any other part of the body. Indeed I have, in some obscure cases, been led correctly to refer the chief locality of the disorder to this organ by the effect which follows purely moral causes. I allude mainly to that unfortunate class of hospital patients, female domestics who have left their places from ill health. The anxiety to recover often prevents the desired result, and the kindness or harshness of a visit from the mistress may be distinctly traced in the advances or relapses on the succeeding day. When this is observed to be the case, it is striking how often the stomach will be found to be the organ chiefly at fault.

A remarkable instance of this influence of moral causes (over ulceration especially) occurred in a patient of Mr. Ballard's, whose case is narrated by Dr. Jones.* "A gentleman, fifty-eight years of age, had suffered upwards of twenty years with occasional attacks of pyrosis and pain in the epigastrium, and continued to do so till within eighteen months of his death, when business of a profitable nature took him to Madeira and back twice in the space of nine months; during this time being probably freer from anxiety and care, and perhaps living better than at any previous time of his life, he did not once suffer from his complaint. On his last return home, he appeared much younger, and was stout and well. This good state continued for some time, but as trouble again invaded him, so did his disease; he suffered loss of appetite and pain, which was relieved by vomiting. At length, when overwhelmed by pecuniary difficulties, he was seized in the street with violent pain and faintness, after which he survived only forty-eight hours." On *post-mortem* examination an ulcer was found to involve nearly the whole circumference of the pylorus, and at the anterior part to have perforated the coats. This case illustrates very well the beneficial effect of means capable of raising and invigorating the general power, though no restriction is laid on the patient's diet. There is a very strong presumption that had this person's circumstances continued favourable, his dyspepsia would not have returned, his gastric mucous membrane would have functioned properly, and his ulcer would have healed. For this reason I would always recommend, where it is practicable, travelling; especially that sort of travelling which was so beneficial in the case above quoted, a sea voyage to a warm climate. In tropical countries people seem able to attain a paradisiacal state of drowsiness, ruinous indeed to national prosperity and to the healthy mind and body, but extremely beneficial for a short time as a medicine to a real invalid. In his *Health-trip to the Tropics*, Mr. Willis remarks that "breathing, which is among the negative sensations in other climates, seemed to me a positive pleasure—as positive as delicious feeding when hungry—in the balmy sea of the Lesser Antilles. I could have heartily said grace after every breath." Under our northern skies some care and anxiety are requisite to enjoy anything, and ten times more to gain the means of acquiring it, but there the bounteous air rains ripe luxury all for nothing. A powerful means is thus afforded for relieving the body of those carking influences of the fidgetty mind which, in gastric complaints more than any others, retard cure.

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* *On Morbid Conditions of the Stomach*, p. 214.

SECTION VIII.—*Cancer, and other Mechanical Impediments.*

I hold with Dr. Wedl, "That a classification of cancer according to its external habit, or according to its microscopic structure, is in reality impossible, because its forms pass one into another, and exhibit a combination of different forms in the same tumour. There is but ONE cancer, whose various aspects are caused by the combined quantity and quality of the organization it attains,"[*] and, it might be added, by the nature of the tissue and by the degree of nutriment afforded from the organ it settles in.

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[*] Wedl's *Grundzüge der Pathologischen Histologie*, p. 631.

Doubts are often expressed whether the name of "cancer" be rightly assigned to cases of irregular thickening of the walls of the stomach and other parts of the intestinal canal, because of the absence of the peculiar large cells, with numerous nuclei and spindle-like prolongations, and other formed elements, which are common in quick-growing tumours when examined under a microscope. The irregular thickening has been classed under the name of "chronic inflammation," which means nothing.

Now I cannot think this absence of *soi-disants* "cancer cells" an argument of any consequence. They are absent from many parts, and sometimes from the whole of malignant growths; and the more we know of tumours the less we pin our faith in these "cancer cells" as distinctive of that from whence their name is received.

The real fact appears likely to be, that these many-nucleated cells are peculiar to quick endogenous growth, and do not show the nature of new formation at all, but merely the rapidity of their increase.

Now the morbid state of the viscera we are considering, very rarely is of quick growth; we have all seen instances of its going on for years and years with scarce an alteration; and hence it is not so surprising that even such a sharp-eyed microscopist as my colleague, Dr. Jones, should fail to find "cancer cells" in conditions of the stomach whose malignant nature was evidenced by the existence of cancer elsewhere.*

The proof of the really cancerous nature of this condition of stomach is shown by the frequency of its association with more readily identified malignant growth in other parts of the same body. In the 2161 cases examined during ten years at St. George's Hospital, there were 199 cases of apparent malignant disease. In 34 of these the stomach was affected, but in only 12 alone, in the other 22 some other distant part, not continuous, or in any way joined by continuity of tissue, was a partaker of the same morbid appearance.* In another case, not included in the above,† the stomach was so slightly thickened that, looked at alone, it could not have been pronounced cancerous by anybody, yet was declared to have that nature by the affection of the œsophagus with decided cancer.

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* "In none of these cases did the cancerous growth itself consist of cells of corpuscles, that could have been declared positively to have belonged to a malignant tumour." Dr. H. Jones *On Morbid Conditions of the Stomach*, p. 168.

The real practical points about cancer are—

1. That it possesses a power of independent cell-growth—that is to say, that its particles, though at first they may be a degeneration of healthy particles, yet are capable of producing others, morbid like themselves, from the normal fluids they are nourished with.

2. That it is injurious just in proportion as by its shape it interferes with vital functions.

The first point is still *sub judice*, and this is not the place to discuss it. If the essence of cancer consists in a power of separate growth, and not upon the substance of the tumour, or upon any cancerous constitution of the whole body, many of the mysteries of its history will be cleared up. We shall be able to understand how, in a tumour or part of a tumour arrested in its growth or growing slowly, the so-called cancer cells belonging to quick growth may be found in diminished quantity, and at last absent altogether. We shall be able to understand how a most malignant-looking tumour, removed before its poisonous cells have got into the blood, does not appear again; whilst one of very doubtful aspect, which has remained long enough to infect the circulating medium, disappoints the hopes of the surgeon by returning. As the notion becomes impressed on our minds, we shall understand that a tumour may be designated as "more" or "less" cancerous—that, in fact, there are degrees of malignancy, or quick growth, as of every other morbid process, and that according to the degree so is the visible aspect.

It is probable that the degree of growth may be dependent partly on the *normal* degree of growth of the part where the cancer is inserted, and that this may account for the rarity of quick-growing cells in cancer of the alimentary canal wall. No great quantity of substance has to be renewed in this thin tube, and therefore the bloodvessels which supply it cannot nourish quick growth so readily as the bloodvessels going to other more rapidly changing parts.

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* See "Decennium Pathologicum," by the present author, in *Medico-Chirurgical Review*, July, 1853, p. 247; or p. 151 of the corrected copy in the Medico-Chirurgical Library.

† *St. George's Post-Mortem Book*, 1845. Folio 282.

That tumours are injurious just in proportion as they mechanically interfere with vital functions, is a matter of clinical experience which only has to be mentioned to be clear to every practitioner. The size which they attain in the liver and ovaries, before destroying life, may be seen in any museum, and I lately had an infant under my care, seeing it occasionally for a year, cheerful and well, in which the left kidney was absorbed by a fibroid and gelatinous cancer, considerably bigger than the patient's head: whilst, on the other hand, life is lost by a tumour as big as a pea in the brain or the heart.

The reason is, that in the liver there is plenty of room for both cancerous and healthy growth; that one kidney and one ovary, or even both ovaries, may be destroyed without obstructing vital acts, but that such is not the case in the centres of innervation and circulation.

Cancer of the stomach may interfere with the process of digestion in several ways:—

1. Its shape may impede the progress of the alimentary mass.
2. It may contract adhesion of the peritoneum to neighbouring parts.
3. It may involve the mucous membrane, become ulcerated, stop the peristaltic motion, open the bloodvessels, cause vomiting, and all the other evils described as belonging to the ulcerated condition.

It will be seen that all these three are more or less mechanical interferences.

The impediment to the progress of the alimentary mass afforded by unulcerated cancer in the stomach, is strikingly small. I had lately under my care at St. Mary's for six months, a man with great cancerous tumours of the liver, which finally killed him. After death a nodular cancerous mass, an inch thick, was found to surround completely the pyloric end of the stomach, involving the whole substance of the canal, except the mucous membrane. Yet this man had at no time any difficulty in digesting the more than ordinary quantity of animal and vegetable food which was allowed him, had no indigestion or vomiting, nor had he ever any pain in the epigastrium till his last fortnight, when there was peritonitis at the other end of the stomach, from the growth of cancerous tumours in the omentum.

Adhesion of the stomach to the neighbouring parts, as a consequence of previous inflammation, is not common without the co-existence of such serious disease as complicates the attribution of symptoms to it. I am inclined to think, however, that it does not as a rule interfere much with digestion, and that the cases where it does so are the exceptions. The following are the only cases I have in my notes bearing directly on this point:—

A woman, aged fifty, a patient of Dr. Macleod's at St. George's, in 1845, had her stomach adherent to her liver, without any ulceration or other disease of the former. She had pain from half an hour to an hour after meals, from compression of the duodenum by tumours in the liver, but *none immediately after food*, as she would have had if the stomach had been inconvenienced by the adhesions.*

Another, a man of fifty-eight, had old adhesions of the stomach, with the mucous membrane healthy, and no gastric symptoms at all before death.†

All other detailed cases of adhesions that I can find had either some ulceration of the stomach, or tubercular or malignant disease of the peritoneum, or neighbouring abcesses, which explains the symptoms without reference to the adhesions.

Though I put down therefore adhesions to neighbouring parts as a possible way in which cancer of stomach may interfere with digestion, I do not think it a probable, and certainly not a frequent way.

The great practical evil of cancer in the stomach is its liability to ulceration. This is the way in which it destroys life, and makes existence a burden.

Cancerous ulcers sometimes eat into the bloodvessels, and cause hæmatemesis, but much seldomer than simple ulcers, as has been already stated. And when the blood is poured out, instead of being thrown up clear and red, it is altered to a brown or black colour, showing that it has exuded slowly, and so had time to be altered by the chemical action of the gastric juice before ejection, as happens in melænic stools. The usual course of illness they induce is one dependent on the starvation and distress of constant vomiting, and on the impossibility of properly digesting the food taken.

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* *St. George's Post-Mortem Book*, 1845. Folio 19.

† Ibid., folio 119.

Cancer is much more common towards the pyloric end of the stomach than the cardiac. Thus of the 34 cases in ten years at St. George's Hospital, in 17 the pylorus alone was affected, and in 2 only was the morbid growth confined to the cardiac extremity.

The tendency of males to this lesion in the stomach is much greater than of females; thus of the 34 fatal cases above named, 23 were males, and 11 of the other sex. And this, too, is in spite of a greater tendency of the latter to malignant disease in general; a tendency evinced by the fact, that of the 2161 cases examined, 13·6 per cent. of the women, and but 5·5 per cent. of the men, were thus affected.*

Remarks on Treatment.

It has been shown that adhesion of the stomach to neighbouring parts, in such a way as to interfere with digestion, is very rare, and that the mechanical impediment offered by cancer and other tumours is very small, as long as the mucous membrane of the stomach is intact; so that the chief aim of the treatment must be to postpone ulceration as long as possible, and when it has taken place to confine its ravages and results.

Now, ulceration of the stomach, there seems every reason to believe, is more likely in an anæmic starved state of system than under opposite circumstances, and if not the direct result of innutritious diet, is certainly aggravated by it; and it is also made much worse by mental anxiety. The advantage of a full nourishing diet was shown in the case of the man mentioned in page 337, whose stomach gave him no trouble, and remained unulcerated till the time of his death, though the pylorus was so extensively cancerous. This advantage also appears in the much greater length of time which persons in affluent circumstances will survive than the poorer classes. The Imperial prisoner at St. Helena lived with cancer of the pylorus three years and a half, even after the symptoms of some obstruction to the motions of the stomach had begun to be evident: but it is very seldom that our hospital patients will attain to a third of that period. The best chance of preserving comparative health is afforded by frequent small meals of nutritious food, such as milk guarded with alkalies, soft-boiled macaroni, scalloped oysters, well gravied mutton, beef tea, and the like. The digestion should always have something to do, while the stomach is spared an overload; even the nocturnal abstinence, which is the best rule for healthy persons, is too long for these invalids, and a cup of beef tea on going to bed, or in the middle of the night is a safe precaution for them.

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* "Decennium Pathologicum," in *Medico-Chirurgical Review*, July, 1858.

When ulceration has once begun in the mucous membrane from cancer, it requires the same management as when it arises from other causes; and treated in this way, and with such views of the nature of what we have to do with, is much more capable of relief than the incurability of its origin would have led one to expect. It is very possible to prevent the stomach from being the cause of death; and if possible, it is decidedly most desirable, for of all terminations of existence, those by perforation of the hollow viscera, hæmatemesis, or excessive vomiting, to which gastric ulceration leads when unchecked, are the most distressing and rapid. It is unnecessary to repeat further what has before been said about the nature and treatment of ulceration, which is equally applicable to the lesion when secondary to cancer, as when primary.

SECTION IX.—*Dilated Stomach.*

I cannot help thinking that the majority of the cases which are viewed as dilatation of the stomach are congenital malformations, and not so much the consequences as the causes of disease. For I cannot find that any one has ever observed the dilatation either to increase or diminish, although in truth the inconveniences (if any) which it gives rise to may be considerably modified. And in all the well-marked instances I have seen, there has been a decided aberration of shape as well as of size, and in many an unnatural position: phenomena more likely to accompany a congenital than an acquired state.

It is observed that the mucous membrane is usually covered with a tenacious secretion,[*] but whether this is a cause or a consequence of the large size of the viscus, is not easy to determine. Chronic mucous flux is not, in the case of the other hollow viscera, accompanied by dilatation; generally indeed, as in the case of the bladder, such a condition of interior is usually followed by contraction. But still in the bronchi truly we do see a sequence of events which would justify us in holding the altered mucous membrane as an origin of change of size.

On examination after death, a dilated stomach is usually found to contain a large quantity of liquid matters. Hence it has been laid down that voluntary over-distension by gluttonous feeding is a cause of dilatation.[†] However, the largest stomach I ever saw was in a young delicate woman, who died under my care of ulcerated œsophagus, who was by her disorder nearly starved during the last two months of her life, and who always had a small appetite. In eight cases of dilated stomach recorded during ten years at St. George's, three had gastric cancer, two chronic ulcer, two had dropsy from diseased hearts and livers, and one was a healthy but very poor woman, who broke her back by tumbling off a cart. Five of these were prevented by disease, and the rest probably by circumstances, from eating too much, so that I am disposed to think the attribution of dilated stomach to over-feeding to be a flight of imagination.

There is however one habit which both physiology and observation make me think likely to induce dilatation of the stomach, and that is tight lacing of the waist during the tender years of youth. One of the five non-malignant cases above quoted from St. George's, the case of my own with ulcerated œsophagus, had very considerable distortion of the ribs, and one can easily conceive that the sideways pressure on the organ, filled as it usually is pretty well by the natural appetite of youth, at a time when the body is attaining its complete shape, may lead it to grow of an abnormal form, in the same way that the liver does from the same cause. Tight-laced women are apt at about forty to have big stomachs and red noses.

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[*] Dr. Bamberger, in *Virchow's Handbuch der spec. Pathologie und Therapie.* VIter Bd., Ister Abth., s. 327.

[†] Dr. Bamberger, as before cited.

PART II.

MORBID ACTS CONSEQUENT ON MORBID CONDITIONS OF STOMACH.

The general effects of gastric derangements on digestion may be classed under three main heads; viz.—

Disturbance of the peristaltic motion, or muscular atony, producing vomiting;

The diminution of the supply of the special solvent;

The induction of pain in the epigastrium.

SECTION I.—*Muscular Atony and Vomiting.*

In most structural diseases of the stomach, the peristaltic wave of the muscular coat cannot but be much interfered with. The consequences of this interference are a relaxation of the œsophagus, a compression instead of a wave in the stomach and vomiting. The same result follows when, from excessive mental emotion, the nerves of the gullet experience a temporary paralysis; so that vomiting is produced by disappointment, surprise, anxiety, nay, sometimes even by joy and pleasure. Still more strikingly is vomiting brought on by the stoppage of the peristaltic wave in the intestines, such as occurs in ileus, hernia, intus-susception, and peritonitis.

Vomiting from arrest of the peristaltic wave has been sometimes referred to a reversal of that muscular act which carries the alimentary mass onwards—to an *anti*-peristaltic motion. But there seems to me no evidence that such is the case: indeed, an attentive consideration of the phenomena of the act itself would seem to show evidence to the contrary. Reflect on the peristaltic motion—it is slow, continuous, and uniform; possessing indeed strength in its steady force, but no irresistible impetus. Compare this with vomiting, and note the difference: here we have a violent explosive power, like a force pump, throwing the ejected matters out to a considerable distance—can there be a greater contrast between two acts of the same part? The most natural explanation of vomiting seems to me that which would represent it as a relaxation or temporary paralysis of the longitudinal muscles of the cardia and œsophagus, and a spasmodic simultaneous contraction of all circular fibres at once, instead of a continuous intermittent one of successive fibres. This, assisted by the consentaneous action of the voluntary abdominal muscles and diaphragm, would expel the matters from the alimentary canal with a force such we see in vomiting, and which could never be attained by the peristaltic action.

Something analogous to what takes place in the sudden spasmodic act of vomiting from complete arrest of the peristaltic wave, may be supposed to be the result of slowness or weakness of the same muscular motion. And such indeed we find to be the case in all decided instances of universal muscular atony. In fevers, for instance, where the imperfect power of contraction in the contractile fibrous tissues is shown by the difficulty in moving the limbs and body, we have nausea and vomiting. In general paralysis and cerebral diseases the same symptom occurs. Emetics—especially the slower acting emetics, such as tobacco and the motion of a ship—produce a relaxation of the voluntary muscles. So that, as a rule, where there is vomiting, there is atony of muscular fibre, and where there is atony of muscular fibre there is a tendency to vomit.

I have seen a gradual loss of power in the arms, finally amounting to actual paralysis, arise from excessive gastric dyspepsia. The dyspepsia was of the sort described above as atony or want of tone, accompanied by vomiting, and in a case under my own care, was attributable to pressure on the epigastrium in the man's trade of shoemaker.

In some cases the atony appears to be more local than in others, as for example in the action of emetics, where the force of the drug falls mainly on the stomach, and secondarily on the limbs; and possibly in some it may be entirely local—an approach to which is made in the quickly-acting emetics, such as sulphate of zinc, which produces much less depression than most other drugs of the same character. But in all there is sufficient evidence to consider the muscular state in vomiting to be one of relaxation or atony, and to view as the main muscular manifestation of atony in the stomach, a tendency to vomit.

Unusual or too long-continued bodily exertion, long exposure to cold or heat, and other circumstances peculiarly exhaustive of muscular and nervous power, before eating even a moderate meal, will in some persons produce vomiting, accompanied by deadly faintness. The pathological explanation of this is probably a state of absolute atony of the stomach and œsophagus, which causes the food, directly it begins to swell up with fermentation, to be rejected by the action of the diaphragm. What is remarkable in these cases is, that there is evidently no deficiency of acidification in the stomach, for the ejecta always violently edge the teeth; so that gastric secretion is apparently not arrested. The continuance of secretion independently of nervous influence is quite consistent with the observations related in the physiological part of this volume.*

Vomiting injures digestion by cutting off the supplies before they have had time to be absorbed by the membrane, indeed before they have got to the main agent of absorption, the small intestines. It is unnecessary to say that its effects must be emaciation and debility in proportion as it partially or completely evacuates the contents of the stomach, and that it is harmless in proportion to the quantity of food it allows to pass the pylorus. It is important in the direct ratio of its extent, and on the other hand its real extent may be judged of by its effects in reducing the patient to weakness or inanition. In cases where great wasting of the tissues is found, we may be sure that the vomiting, even though it may be rare, does not allow food to pass the pylorus; while on the other hand, however frequent it is without emaciation, we may know that a sufficiency of nourishment arrives at the main absorbing points of the alimentary canal. Thus in cancer of the duodenum I have seen extreme marasmus follow the ejection of the contents of the stomach but twice a day; while with ulceration of the cardia and œsophagus I have a patient now under my care gaining weight, though vomiting accompanies every attempt to swallow even two ounces at once of the milk on which she lives. Vomiting is a symptom which must be *valued*, not *numbered*.

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* p. 41.

This is a matter of some importance in the treatment of it. We must not be satisfied with the reduction of merely the number of times a patient vomits in the day, if emaciation still continues to advance. We have indeed relieved a distressing inconvenience, but we have not lengthened life; and we ought to prolong our efforts till weight ceases to be lost. Again, the mere fact that a food excites retching, is not absolutely condemnatory of it, for it may be of such a nature that some of it passes onwards as a nutriment, though the bulk may be thrown back into the mouth.

Atony, not amounting at first to actual vomiting, but marked by excessive weight at the pit of the stomach, and leading finally to vomiting and other gastric diseases as well, is the most usual consequence to the stomach of the epigastric pressure practised by shoemakers. It is probably to be explained as a sort of paralysis from too partial exercise of one muscular part, which beginning in the stomach, induces chronic vomiting, and affecting also the intestines and colon, is exhibited in biliousness, obstinate constipation, and hæmorrhoids.

A condition not very dissimilar is produced in tailors, by the constrained position in which they work making the peristaltic muscles act at a disadvantage; and sometimes through the compression of the epigastrium in young women by ill-fitted stays; by leaning against the desk, in literary men and accountants; and by the awkward unnatural posture in which miners work. In all these however the part first affected is not so often the stomach as the small intestines and the colon.

Remarks on Treatment.

The best remedy for vomiting is a diet of a mixture of equal parts of milk and lime-water. If this is not sufficient alone, I give hydrocyanic acid, hydrocyanate of soda, trisnitrate of bismuth, first separately, and then combined. *When these have failed*, I cannot say I have ever found creosote, burnt brandy, or opiates succeed; though in the hands of others I am quite willing to credit the benefit they have conferred, especially when the first chance has been given to them.

In cases where a chronic muscular debility is evidenced in the stomach by a disposition to vomit too easily, and on too slight a provocation, the sudden application of cold is often of great service. In weakly hysterical females the vomiting of this kind, which so often resists the action of all sorts of anti-emetics, is checked by a shower bath better than by any remedy I know of. And I see no reason why it should not be equally beneficial to males in the same predicament, in those rare instances where it occurs. If for various reasons it is not desirable to subject the head and the whole person to such a shock, a local douche-bath to the epigastrium may be tried; but I must confess I have not seen the same beneficial results from it as from the first. On the same principle as sudden cold, stimulants—such as æther, valerian, ammonia—serve a temporary purpose, but they do not confer the lasting benefit which arises from the remedy first named.

While speaking of shower baths as a remedy for atony of the digestive organs, I would remark that we must be careful to guard against that coldness of the extremities to which all dyspeptics are subject, and which is often increased by incautious bathing, and sets the patient against the remedy. The best mode of obviating this real inconvenience, is to stand with the feet in warm water while the cold falls on the upper part of the body, and to prepare the arms for what they have to submit to by placing them for a moment in water sufficiently hot to redden the skin. The cold then, instead of chilling, produces a glowing reaction, and is followed by a hard firmness of contraction in those muscles which we can pinch and feel, and therefore I suppose is beneficial in a similar ratio to those out of our reach.

Where atony has been produced by pressure, a complete cure is often produced by simply leaving off that pressure. Shoemakers have been sitting in a constrained posture since the days of Pharaoh Thothmes III., the oppressor of the Israelites (as may be seen by the paintings in the British Museum), and therefore must always have suffered from it. This posture and the epigastric pressure have been shown by Mr. Sparkes Hall to be quite unnecessary, the upright bench which he has invented (in consequence as he says, of some humble suggestions of mine) entirely superseding them, enabling the artisan to stand or sit at his work, according to his pleasure, to hold the shoe tight at any distance from the body, to expand and use freely all the muscles of the chest, and in fact rendering shoemaking one of the most healthful of employments, while at the same time the delicacy of the work is not interfered with. Several of Mr. Hall's best hands, who were always ill under the old system, declare they can work as long as required at this bench, and it is gratifying to know that the highest personage in the land has her boots made without injuring the digestion of one of her subjects. The application of similar expedients to tailors, literary men, and others is, obvious.

SECTION II.—*Imperfect Gastric Digestion.*

The diminution of the supply of gastric juice consequent on morbid states of the stomach, rarely causes the same amount of emaciation as vomiting does. In fact the place of the gastric solvent is in a great measure taken by the intestines in case of need, and the meat is dissolved in the same part where it is absorbed. So that where in these cases any notable emaciation is found, it may be strongly suspected that the lesion whence it arises is lower down, as well as in the stomach.

The effects on the digestion of *albuminous food* produced by deficiency of the gastric juice, are to take away its natural main solvent. But, as stated above, its solution and absorption is thus diminished in quantity and rapidity only, and by no means entirely put a stop to. Hence in such cases of deficiency the supply of nutriment to the muscles and other fibrous parts may be said rather to be made with labour and pain than to be cut off.

The effects on *starchy foods* are to take away from the stomach the power of dissolving the albuminous envelope of the starch granule in unbroken grains. Hence raw vegetables are peculiarly objectionable to weakly stomachs. The delay also of the albuminous matters in the stomach causes the starch to be delayed at the same time, and to undergo decomposition. From the sensitive state of the nerves, this decomposition is peculiarly offensive to them, and causes more inconvenience than even the changes of the albumen. It seems also not impossible that starch in its decompositions may be converted into oil, and be absorbed to form adipose tissue, and so contribute to that obesity which, as will be remarked presently, is not uncommon in gastric disorders.

Fat and oil not being liable to digestion in the stomach, are unaffected by the deficiency of gastric juice, except when, in its fresh state among animal tissues, it is contained in an envelope of cellular membrane; in which case it would be more likely to pass through a weakly stomach unaltered, than through a healthy one. Dr. E. Schröder found that in the healthy stomach of his patient with gastric fistula, adipose tissue which was swallowed became so far disintegrated that the oil was freed from the areolar sacs which contained it, united into drops, and floated free in the fluids around it.* This would not happen without the agency of gastric juice, and where that solvent is not supplied in full quantity, would be imperfectly performed. It is true that the defect would be partially supplied by intestinal digestion, but still in weakly persons lumps of fat, very much in the state in which they were swallowed, are sometimes passed with the fæces, probably in consequence of this non-digestion of their cellular covering.

Fat which is at all rancid, or on the point of becoming so when eaten, is often decomposed in the stomach, and causes inconvenience in the same way that starchy food does. But in the majority of instances fat which does not become rancid is absorbed easily by gastric sufferers, and many become obese by taking up their full allowance of it, while their muscles are weakened by the non-assimilation of albuminous nutriment.

The obesity of persons with weak gastric digestion is peculiarly distressing: the defect in muscular power prevents the use of exercise for a time sufficient to prevent its increase, and hence it becomes a daily augmented inconvenience. The encroachment also of the adipose upon the other tissues, and the dilution of the insufficient blood through an unnaturally large quantity of capillaries, tend to produce atrophy of important parts; and hence we find as consequences of corpulence, dilatations and degenerations of the heart, fatty deposits on the same, Bright's kidneys, dropsy, &c. The addition of many pounds to the body in the shape of fat, requires certainly a very large, although not perhaps a proportionate, addition of blood and bloodvessels to nourish it; yet the same heart has still to undertake this extra labour. The balance then between the systemic and the pulmonary circulation must be destroyed, and the lungs be unequal to the secretion of so much more carbon than they were made for; hence the blood becomes more venous, more liable to form congestions, and to dilate the cardiac cavity by its retarded pace. The effect of diminished circulation in also producing degeneration of other parts need not be enlarged upon.*

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* *Succi Gastrici Humani vis digestiva*, &c., p. 30.

Aqueous fluids in large quantities during meals burden the stomach with an extra bulk of matter, and therefore often cause pain and discomfort; but that they retard digestion I do not believe. Indeed, among the sufferers from gastric derangements of all kinds, cases frequently occur of those who cannot digest at all without a much more fluid diet than is usual among healthy persons.

The effect of accessory fluids, especially *alcohol*, on gastric disorders is various. In the great majority of instances their immediate result is to retard digestion by still further preventing the secretion gastric of juice, as Dr. Beaumont has observed. But still they are in the end often beneficial by preventing destruction, and giving the individual strength to digest better.

Remarks on Treatment.

As we may intrust to the intestines the digestion of a considerable amount of albuminous food, we need not be sparing of it to patients with gastric disorders. Only we must take care that it does not remain long in the stomach, or be offered in too large quantities at a time, so as to burden the weak organ unnecessarily. Milk, broths, gravy, and jelly will often afford nutriment to patients who seem to have really no gastric juice at all, so utterly destroyed is the whole texture of the viscus which secretes it.

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* This subject has been already illustrated by the author from the *post-mortem* records of St. George's Hospital, in his work *On Corpulence*, chap. ix. p. 116; and in the "Decennium Pathologicum," *Medico-Chirurgical Review*, October, 1853, p. 489.

The difference between one sort of albuminous food and another lies principally in the ease with which it is capable of being broken up, or its liability on the other hand to collect into a solid mass. Pure masses of albuminous food, such as coagulated white of egg, the vegetable gluten of wheat in the form of macaroni and the like, are not easily penetrated by the gastric juice, though when diffused through other victuals they are digestible enough.

The tissues of various animals differ from one another in suitability for the weakened stomach of gastric invalids, according to the looseness or closeness of their texture, the solubility of the ultimate fibre, and the substances which divide the fibres or bundles of fibres; and several which are suitable in one respect are unsuitable in another, unless artificial preparation can obviate the objection. In a future chapter will be discussed several of the questions which arise out of this subject, as to the digestibility of different meat dishes, and the modes of removing the impediments of their usefulness.

Starchy food we must be very cautious of. It is more bulky in proportion to its satisfying qualities than meat, and therefore dilates and oppresses the epigastrium. The very fact of its not naturally requiring the offices of the stomach for its digestion, makes it a peculiarly foreign body, and obnoxious to that viscus.

Yet it is hardly possible to live entirely without starch, and hence any means which will render it as little liable as possible to remain above the pylorus and form a solid mass, are valuable. The most complete method for the disintegration of amylaceous food is to bake it slowly, by moderate heat, into a solid hard form, without ferment, and then to soften down this in fluid. A captain's biscuit, steeped till quite soft in water or milk, can be borne by stomachs which can bear nothing else; and from the comfort it affords comes to be considered as the most palatable of dishes. Biscuit is more suitable for gastric sufferers than bread, stale bread than new bread, because it is less likely to form a solid mass by chewing. Mealy potatoes, mashed, and mixed with a sufficient quantity of gravy to make them almost fluid, are the best vegetable of those usually employed at table.

It is very possible to take starchy food alone when it cannot be borne mixed with albuminous food; and it is always worth while to try this experiment, by way of varying the diet as much as possible. Tapioca, sago, ground rice, &c., may often be taken for luncheon with impunity, when, if eaten after a meal in the ordinary way, they excite gastric disorder. The same rule holds good of fruit, and indeed of almost all articles of diet.

Fatty food can be taken without pain by gastric invalids, very closely in proportion as it is fresh and without rancidity. New-made butter often agrees, when the empyreumatic fat in baked meat makes it utterly indigestible. If there is much emaciation it is right to try several forms of oleaginous food in each case, to see if some cannot be found capable of supplying nutriment to the failing adipose tissue. On the other hand, where there is the tendency to obesity above-mentioned, fatty substances of all kinds—fat meats, and vegetables which contain fat, such as maize, lentils, peas, beans, filberts, nuts, almonds—should be avoided.

Even to the healthy, mixtures of fatty and amylaceous matters are apt to be indigestible; the seeds above named, in which there is a larger proportion of oil than usual combined with the hard, woody, and starchy substratum, are familiarly known as liable to generate wind, that is, to arrest digestion, and to decompose in the ilia and colon: but it is only in invalids that this process takes place so early as in the stomach; in them sometimes most severe spasms and distressing eructations follow the incautious use of such articles.

The way in which fat is distributed among the muscular fibre of flesh meat is one thing that makes it more or less easily soluble by stomachs deficient in gastric juice. Mutton owes its good character for digestibility to the little fat there is among its close-grained fibres, even in joints loaded with adipose tissue; while the flesh of the ox is infiltrated with oleaginous matter throughout. The oil envelops the fibres when in the stomach, prevents their being fermented by the gastric secretion, and so renders beef indigestible to all but robust persons. The absence of fat in fish and in poultry is one great cause of their easy digestibility in the stomach, though their ultimate fibre is less easily soluble than that of red meat, as is shown by its not unfrequently being passed through the bowels and appearing in the fæces. Meat or fish, fried or otherwise dressed with grease, is thereby rendered less digestible to weak stomachs, though to those whose gastric juice is sufficiently plentiful to wash away the oily envelope and penetrate the muscular fibre, it is wholesome; for the heat has full effect on the ultimate fibrils in this mode of cooking.

The best device for allowing the stomach the assistance of a considerable supply of watery fluids without burdening it with an extra weight, is to drink the fluid in small quantities at a time, about an hour after meals.

The liquids, however, usually taken, viz., hot tea and coffee, with milk and sugar, are objectionable in many ways. In the first place, the heat above that of the blood congests still more the congested mucous membrane; then the milk or cream coming on the soured victuals is turned into an extra dose of acid; and the sugar, meeting with the partially fermented mass, ferments also and becomes vinegar. A glass of cold water may with advantage take their place.

The use of accessory drinks which limit destruction—alcohol, tea, coffee, &c. (see before, page 187, &c., Book I.)—must depend on other circumstances than the mere fact of gastric disorder. They are certainly desirable where there is emaciation and continuous loss of flesh, and also where there is any extra exertion required to be made; but where there is a tendency to obesity, or even where there is no emaciation, they are not wanted. Under all circumstances, even while doing good, they at the same time do harm by their direct effects on the mucous membrane at the time of meals, viz., by increasing the already existent congestion. The last meal in the day, after which entire rest can be given to the body, is the only one they should be taken with by weak stomachs, and then they sometimes do good by acting as a fillip to the weakened nerves; when necessary in the course of the day, they should be taken only as medicine, or at a time distant from meals.

SECTION III.—*Pain in the Epigastrium.*

Pain in the epigastrium is described by patients by a great variety of terms, which find their counterpart in the disagreeable sensations faintly attempted thus to be set forth. But to suppose that all the feelings to which different names are assigned are really different in their nature, and from different causes, would show an ignorance of mankind, and of the true powers of language. What two people could describe a prick of a needle or the same toothache in precisely similar terms?

For practical purposes the best classification has seemed to me one of great simplicity—viz., into Painful digestion, and Spasmodic pain.

SECTION III. A.—*Painful Digestion.*

Pain is an accompaniment of most of the disorders of digestion, and when moderate is an useful test to the medical man of the advance or retreat of the disease. Where we can, we should be unwilling to interfere with pain, except through its origin; we should be unwilling to remove it without removing the cause, lest we destroy one of the most important guides which lead us through the dark mazes of nature's works.

But sometimes it constitutes such a marked feature as imperatively to demand special attention and treatment, and not unfrequently it both directly and indirectly aggravates that derangement which has given rise to it.

However, that pain ever constitutes the sole disorder of the stomach, and the sole deranged phenomenon which requires attention, appears by no means a proved, or indeed a probable circumstance. Pathological analogues do not render such a thing likely, for the more we know of morbid states, the narrower is the ground occupied by the pure neuralgias: clinical observation does not contribute any further probability, for we invariably find in closely-watched cases some other morbid phenomenon beyond the pain in the epigastrium: and certainly physiology is against the supposition, for in the natural condition of the surrounding tissues the abdominal nerves are peculiarly insensitive.

Let us continue therefore, as a general rule, to look upon "painful digestion" as a secondary phenomenon upon morbid states of the tissues.

That it is different in degree in different individuals—in some, in spite of severe derangements, being scarcely present at all; in others very excessive, without there being any disorder of sufficient magnitude to account for it—depends on the diversities of the connexion between the mental and nervous system in various persons. It is familiarly noticed by all observers that in nothing is idiosyncrasy so commonly shown as in this particular; there are scarce two persons who feel the simplest injury in exactly a similar way; to one the prick of a pin is torture, while another is scarce awakened from sleep by it; the extraction of a tooth agonizes one patient, while another makes light of a threefold repetition of the operation. And to this natural idiosyncrasy there is superadded the influence of education, by which one is (in expressive schoolboy phrase) "toughened," and another rendered effeminate. All that is shown by the phenomenon of the same intensity of digestion producing different intensities of pain in different cases, is the familiar fact, that individual constitutions have every variety of perception of pain, from complete apathy to incredible sensibility.

The way in which the peculiar sensibility of some individuals to pain in the epigastrium acts in making the gastric disorder worse, is by attracting the attention of the mind to the part, and depressing the spirits. Both attention and depression are great disturbers of all unconscious organic acts, and upon digestion in the stomach they act with peculiar force, arresting the flow of gastric juice and the peristaltic wave, and causing by this means acetous fermentation, acid eructations, increased congestion and irritation of the stomach, and consequent heartburn and acid pyrosis.

In this way it is very possible for a sensitive patient to suffer a train of such morbid phenomena as are above described, from a lesion in the stomach of a much less severe character than one which in an obtuse-nerved person attracts no attention, and consequently does not arrest digestion or produce any phenomena.

Pain may occur at various periods of digestion, and the interval between the taking of food and its supervention is some guide, though by no means an infallible one, to the nature of the gastric lesion.

In ulcer the pain in the stomach is usually *constantly* present in a greater or less degree, and is rather aggravated than simply induced by the ingestion of food. Under such circumstances the aggravation occurs immediately the food is swallowed. If the ulcer is in such a torpid condition that the pain goes entirely away for a time, so that the patients can at any period of the day say that they are not aware of their having a stomach, still more if pressure at the epigastrium can be borne, then the pain produced by food does not come on till a longer interval, sometimes as much as an hour has elapsed. The protraction of this interval is a sign that the ulcer has changed from an irritable to a torpid character, and that a consequent change of treatment is required.

Pain from ulcer is always much increased by pressure. Very often it is so slight when no pressure is employed, and so marked when the epigastrium is handled, that it may be rather called tenderness than pain. And when this is the case, I think we have a more certain sign of an ulcer's presence than is afforded by anything except hæmatemesis.

In cancer which has not ulcerated, and in other mechanical impediments, the pain is of a dull aching character, sometimes indeed not to be called pain, but rather a sort of uneasy tickling sensation: it comes on not till about half an hour after meals, and lasts while the stomach is full.

In deficiency of gastric juice there is *no* pain, but a weight and sense of distension, not confined to the epigastrium, and coming on about half an hour after meals, just as the agreeable feelings produced by eating and drinking are subsiding. Discomfort gradually displaces comfort in a way rather characteristic.

This uneasiness in deficiency of gastric juice is apt to be accompanied by palpitations of the heart, pulsations of the aorta, throbbing of the temples, and other nervous symptoms, more commonly than is the case in other gastric disorders. These symptoms go away when the stomach is empty.

In mucous flux there are often the same sensations as in deficiency of gastric juice, and probably from the same cause; but there is added also an uneasy craving sensation, nausea, and often vomiting when the stomach is empty, heartburn and alkaline pyrosis. The symptoms are usually more confined to the stomach than in deficiency of gastric juice, and do not so often produce throbbings and palpitations of the arterial system.

In individuals of a torpid non-responsive sensibility, not only is the pain less in degree, but it is often much longer in travelling from the seat of lesion to the sensorium; so that an ulcer, instead of giving pain immediately food is swallowed, produces in them symptoms more resembling those of deficient gastric juice in other individuals. A diagnosis should not be made without taking the temperament into account.

Patients of the last-named character seldom require that any special treatment should be directed immediately to the pain. It does not aggravate their disorder and is an useful test of its advance or retreat.

But in excitable persons the case is different, and we shall effect a cure much quicker by joining to other remedies those whose province is only sedative. With these patients the sense of weight and oppression is unbearable, the pain amounts to agony, and the nausea and craving absorb all their ideas and thoughts. It is very obvious that this excitability must make the several disorders indicated by the symptoms worse, and that by diminishing it we are aiding nature to cure as well as relieving present distress.

Remarks on Treatment.

The great object to be attained in selecting sedatives for pain is to choose such as, while accomplishing their object, do no subsequent damage.

To gastric ulcer, opium seems the most appropriate sedative, because while relieving the immediate pain, it also very probably reduces the sore place from an irritable to a torpid state, and so renders it in that situation more easy of cure. It is also useful where there is much painful heartburn running up the œsophagus. In a solid form or in powder it has seemed to me more advantageous than in a liquid, and in all three better than the salts of morphia; the reason probably being some mechanical differences in the facilities for solution at the right moment.

In mucous flux, opium has seemed to me to do harm, by producing constipation and affording no permanent relief. Hydrocyanic acid is here indicated, and may be given fearlessly, for I am not aware that any harm ever follows medicinal doses of this powerful drug. Even when I give opium, I usually combine hydrocyanic acid with it.

The nausea and craving of gastric flux are often capable of relief by a draught of vinegar, or phosphoric or muriatic acid. Where these are not sufficient, and where the distress justifies such a disagreeable remedy, an emetic removes the cause, and often rewards the patient for the resolution shown in taking it by a return of healthy appetite.

Distress, not amounting to pain after meals is best relieved by alkalies and diluents, especially the latter. A glass of water will sometimes act like a charm, and will remove the most alarming palpitations of the heart and other nervous symptoms.

Patients are sometimes loath to take alkalies as a palliative measure, because they observe that the use of them becomes habitual, and that an increased dose is often requisite in those who take them; concluding from this that the disorder is made worse by the drug. I do not think such its real effect, and explain the undoubted fact of a continued and sometimes an increased use of alkalies being necessary to comfort in this way, viz., that the inconveniences arising from the disease being removed, though not the disease itself, patients are disposed to be less prudent than they ought to be in the quantity and quality of their victuals, and hence require an augmentation of that which is to compensate for the excess. For this reason I do not advise alkalies to be employed as palliatives in mild cases —I would palliate those by a cure—but only where the distress is unusually great, or from peculiar circumstances cannot otherwise be alleviated.

Other remedies for pain in the epigastrium, such as bismuth, nitrate of silver, &c., appear to act as curatives, and have been already mentioned under such description. These last require less judgment in their selection and employment than palliatives to pain do, and cause the prescriber much less anxiety. They have the great advantage, that we may in chronic cases judge of their future by their effects: if they do good immediately, *à fortiori* they will do so afterwards:—whereas palliatives often act as a mask to the symptoms by which we are to guide our course.

SECTION III. B.—*Spasmodic Pain.*

Pain of that sort which is familiarly known as "spasmodic"—that is to say, *very local, very sharp, and gradually increasing in intensity until a certain degree is attained, and afterwards declining*—is often felt between the navel and the sternum. It is relieved by gentle pressure over a broad space, but very often sudden pressure or the localized touch of one or two fingers is shrunk from.

Such sort of pain is most commonly the result of imprudence in healthy persons, but is not wholly unknown to chronic invalids, occurring occasionally in cases of gastric mucous flux, of ulcer, and of malignant disease. The exciting cause, however, even in these latter cases, is traceable to something external, and is not dependent on the disease itself.

Spasmodic pain in any part of the abdomen is accompanied by hardening and contraction of the parietal muscles over the seat of it, and it also strongly resembles that which is felt in cramp of the limbs. Hence an idea has arisen that it is due to a tonic contraction of the peristaltic fibres of the hollow viscera.

But, in the first place, contraction of the muscular parietes is caused by any sort of pain of internal parts—as for instance, by pleurisy, and other internal inflammations—and therefore such contraction is no proof of the nature of the internal morbid state. And, secondly, the resemblance of the pain to cramp is no proof that cramp exists, for gout, sciatica, and neuralgia will often produce feelings exactly like cramp, which are accompanied by relaxation rather than by contraction of muscular fibre.

At the same time there are several things which to my mind appear to militate *against* such a supposition. In the first place physical examination in almost all cases shows evidence of the area of the canal being increased during spasmodic pain:—there is either a larger extent than natural of dulness on percussion, arising from solid contents, or of resonance from gas. Again, *post-mortem* observation confirms this in such well marked cases of spasmodic pain as are followed by fatal results; for instance in ileus, lead colic, and hernia. To be sure, there is usually a contracted part as well, but the seat of the pain corresponds more closely to the dilated. Then again, spasmodic pain is usually relieved, not like cramp, by stretching the muscle to its full, but by emptying the contents of the hollow viscus, and so allowing the circular fibres to contract still more, if they were disposed to do so.

I am inclined, therefore, to associate spasmodic pain with dilatation in most cases, while I do not know of any where I could refer it to contraction of the muscular coat of the alimentary canal.

When spasmodic pain lies between the navel and the sternum, its cause may commonly be referred to the stomach; and when that viscus is emptied, the nature of its contents is usually sufficient to explain the occurrence of morbid phenomena.

The solid contents which most commonly are the cause of distension, are matters, either absolutely in themselves or under the circumstances of the case, insoluble in the gastric juice. The woody fibre of some fruits and the envelopes of seeds, when eaten in excess and not sufficiently separated by other food, adhere together in masses, and perhaps collect other articles around them like an avalanche, by the aid of the mucus which the membrane pours out to defend itself, and so become incapable of being washed onwards by the gastric juice. Pears, for instance, apples, fresh figs, fruit stones, are frequent causes in children: cherries and plums, though so soft and juicy, have very tough skins, which, even without the churning of the stomach, will form a mass very coherent and difficult of penetration. Labourers employed in threshing often suffer the same from eating fresh corn, whose bulky envelope is bound together by the tenacious gluten into a monstrous bolus, unbearable even by the proverbial *dura messorum ilia.* Large quantities of milk taken at once, and still more the curds, which in Devonshire are sometimes eaten as pudding, form a mass of fresh cheese sufficient to resist all solvents.

Of such sort are the most usual excitants of pain from distension of the stomach. But sometimes in gastric flux the collected mucus and saliva will form an equally foreign and equally heavy burden to the labouring organ, and will cause spasmodic pain till it is rejected.

And in the same form of derangement there is often formed a great collection of wind in the stomach, especially at night on going to bed. This distension by gases produces symptoms not appreciably different from that arising from solid or fluid matters: they usually burst upwards into the mouth with great force, and then the spasmodic pain is shortly relieved. The same flatulent distension not also unfrequently accompanies ulcer and other gastric disorders that impede the progress of the alimentary mass, and cause fermentation to take the place of digestion.

The inodorus character of the flatus expelled from the stomach, and its rapid re-collection again after it has been expelled, have suggested that much of it is secreted in the viscus. It is impossible to deny that it may be given out from the blood under ordinary circumstances, as was before shown (page 155), but the very fact of its rapid formation seems to be against the idea that such a proceeding takes place wholly in the stomach. I am inclined to ascribe its re-collection to a relaxation of the pylorus, which allows the air of the intestines, expanded as it is by heat, to regurgitate into the stomach, and so to be expelled by belching.

Other causes of spasmodic pain in persons affected with some chronic lesion of the stomach, are entirely unconnected with distension, and seem dependent on morbid sensitiveness of the part. Sometimes this morbid sensitiveness arises from exposure of the nerve by a sore place, as in ulceration, in which case the spasmodic pains that occur may be compared to those sudden and violent toothaches which come on in a similarly spasmodic manner from caries laying bare the nerves of the pulp. Sometimes it is more akin to rheumatism, and is excited by the same causes, such as exposure to cold or change of temperature. In the first case it is usually some lumpy article of food which excites the symptom; in the latter case, cold and wet weather; getting wet when heated, a shower bath or incautious cold sponging, or a draught of cold water, will bring on most violent pains in the epigastrium—sometimes indeed so violent as to cause fainting and most alarming consequences.

This last form of spasmodic pain is most frequent in gouty and rheumatic patients, and I cannot help thinking it is really a way which the gouty and rheumatic poisons have of attacking the abdominal viscera. Its supervention in them is remarkably sudden, quite as much so as gout in the great toe or lumbago in the back, and its decline will often be equally capricious, exciting however, while it lasts, excessive alarm and agony.

Remarks on Treatment.

The remedy of evacuation is rational and simple. It always relieves the pain in the end by taking away its cause; but unless used early, it is not so immediately successful as is generally anticipated. The pain, and still more the soreness at the epigastrium, will often continue equally bad for a long time after the stomach has been completely emptied.

The explanation of this is twofold; first, the communication between the sympathetic system and the seat of feeling is so imperfect, that sensations and changes in sensations are carried to the mind only after a considerable interval, and that a pain once commenced takes a long time to be appeased; secondly, the mass which has caused the distension may, with great labour, have got through the pylorus, and so not being dislodged by vomiting, may go on causing inconvenience all the way through the intestines.

It might be objected against the last explanation, that in that case the seat of the pain would be removed, would shift lower down with the shifting cause. But such is not necessarily the result of the change; for I have known many instances where ulceration in the colon, many where even ulceration of the small intestines, originally seated in these situations, caused pain in the epigastrium only. Still more likely is it that pain from an acute cause, first situated in the cœlic plexus, should remain there in spite of the cause being more distant.

The best relief for this pain, remaining after evacution, is chloroform, administered both externally and internally, the first on a piece of linen laid on the pit of the stomach, and the latter in some gruel or gum-water, in doses of five drops every ten minutes. Failures will rarely occur.

This remedy is much assisted by hot water, drunk in frequent sips, flavoured, if the patient wishes it, with chamomile, cowslips, or any other harmless simple.

It should be followed up by a watery purgative (say infusion of senna and jalap),* so that the masses which have passed the pylorus may be washed onwards in their way to the rectum.

The same anodyne which has been recommended in cases of spasmodic pain from distension after the stomach has been evacuated, is equally applicable in those described as akin to rheumatism and neuralgia. And here, too, the warm water is a beneficial aid. But the purgative is not required by the circumstances; and indeed if given it is injurious, often turning the epigastric spasm into severe griping, and continuing it longer than it would have otherwise lasted.

Persons subject to this curious form of rheumatism will do well to wear a flannel band round the abdomen, to avoid the sudden ingestion of cold drinks, or the external application of cold water to the abdomen when the stomach is empty, and above all things, to be cautious of bathing in the open air.

In extreme cases, the drinking of lukewarm water at meals instead of drinks at the usual temperature, is a measure which may be adopted with advantage. And in the same cases entire abstinence from all wine, spirits, or fermented liquors, is a *sine quâ non.*

Where this tendency to spasmodic pain has followed residence in a hot climate, and where usually the liver is sluggish, I have seen excellent results follow a residence at Brighton, and a course of hot sea baths, with daily doses, between meals, of non-purgative doses of the Marienbad waters with the chill off. The frequent disappointments which medical men have found from these waters arise from the patients ignorantly taking them on an empty stomach, and of too low a temperature, evils which may be avoided by taking them, as above recommended, between meals.

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* There is no pleasanter addition to a senna draught than from ten to twenty grains of *pulvis jalapæ compositus;* it makes the action quicker, more watery and less griping; and, what is of no little consequence to the sensitive, disguises the nauseous taste of the senna by the agreeable sharpness of its tartaric salt.

CHAPTER V.

MORBID AFFECTIONS OF SMALL INTESTINES INTERFERING WITH DIGESTION.

As of the stomach the marked function was chymifaction, to which others were subordinate, so of the small intestines the main duties in health are absorption and excretion. In addition to these, and supplementary, there goes on at the same time a continuous solution of the remaining alimentary substance in the juices supplied from above, and from the intestines themselves in case of need. But of this latter function we know as yet but little, and the most physiological way, therefore, of making the derangements of the intestines a subject of comment, will be to take first such abnormal states as exhibit a *deficiency of intestinal absorption*, and then those where there is *defective excretion*, making only cursory remarks on the deficiency of intestinal digestion.

PART A.—*Defective Absorption.*

A (*a*). *Defective Absorption in General Disease.*

In all acute, and in most chronic disorders of the general system, the power of absorbing supplies of food to compensate for metamorphic destruction, is defective. At the beginning of acute fevers, and as long as the vital actions are so interfered with that but little metamorphosis takes place, there is no apparent loss: the body keeps up its weight and form, because there is a balance of expenditure and income; both are equally arrested—partially, of course, for complete arrest is synonymous with death. Hence the corpses of those who die early in the disease are full of flesh, and of natural form. The first symptom of a turn towards health is the recovery of the destructive acts, and a certain amount of emaciation always precedes convalescence.

There appears in this phenomenon a suitability and evidence of design which ought not to escape a reverent mind. In these cases there is either introduced or generated, or both introduced and generated, in the body a poisonous substance foreign to its tissues; and it seems most proper that this should be evacuated before there is introduced any more fresh matter than is absolutely essential to keep life up. This propriety did not escape the shrewd mind of Hippocrates when he observed, that the supply of nutriment to morbid tissues is not desirable—*τὰ μὴ καθαρὰ τῶν σωμάτων ὁκόσῳ ἂν θρέψῃς μᾶλλον βλάψεις.*

For this reason, in acute fevers it is of the highest importance to watch for the time when destructive metamorphosis begins to return. Up to that moment any food we give with a really nutritive intention is either useless or noxious; and any complementary food which arrests metamorphosis is a postponement of the favourable turn of the disease. Decoctions of starch, infusions of gum, and fluid gelatinous[*] drinks, are possibly beneficial, by shielding the mucous membrane from irritating substances; but they are not likely to be absorbed, and their chief use is as a placebo to the patient and the friends, who dread starvation.

How far we should interfere to *promote* destruction, by giving neutral salts, water, purgatives, mercurials, &c., must be a question to be decided by the peculiarities of each individual case—peculiarities which it is the business of the special writer on these diseases to point out, and not within the scope of a small volume on the part borne by the digestive organs. In almost every instance I am inclined to think some of these agents beneficial; and among them I would call the attention of practical men to one undeservedly neglected in the present day—viz., the administration of emetics at the onset of fevers. I am sure that by this powerful agent the first period of the fever—the period before the destructive metamorphosis commences—is much shortened, and the subsequent violence of the phenomena abated. The secretions of the alimentary canal arrested in the mucous membrane, and subjected to chemical decay there, are cleared away, and whatever poisonous or noxious matters may have been received into the hollow viscera are removed. Sometimes the recovery of destructive metamorphosis follows immediately on the remedy, and is therefore so slight that the attack is said to be cut short; but more commonly only a temporary stimulation of the vital powers occurs, and the natural latter part of the course of phenomena is gone through.

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[*] See pp. 214, 219.

The recommencement of destruction is announced by the increased amount of solid matter in the fæces, or the increased specific gravity of the urine or perspiration, with the simultaneous alteration of countenance by the falling in of the features, and other evidences of commencing emaciation. Then is the time to let a continuous stream of digestible nutriment begin to flow through the alimentary canal, to be taken up at the auspicious moment when the absorbents are able to receive it.*

Such is the rational and physiological view of the treatment of acute fevers through the digestive organs.

A (β). *Chronic Ulceration.*

There is no disorder of which emaciation is so marked a feature throughout its whole course, as chronic ulceration of the small intestines. Ulcerations of the cæcum and colon, tubercular or not, produce as much, nay often more, diarrhœa; but they are not by any means so distinguished in their power of reducing the patient. In this lesion of the ilia, even the parts which are not the actual seat of disease seem incapacitated from absorbing nutriment, and the victuals pass through the alimentary canal in the same state as when they left the stomach except being made putrid by chemical decomposition: all the stages of digestion are equally suspended.

There is nothing which so surely carries to the grave by consumption persons with tuberculous lungs, as ulceration of the bowels. I have in the "Decennium Pathologicum"† given statistical evidence to show that the likelihood of finding this abdominal lesion after full growth is attained, is in an inverse ratio to the age of the patient; and I there traced the cause of this phenomenon to the more rapid development of phthisis in tubercular persons, if they are the subjects of ulceration of the bowels, and to the less chance there is under such untoward circumstances of the pulmonary disorder becoming dormant or cured.

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* See p. 288.

† "Decennium Pathologicum," chap. vi. sect. i.

The practical inference drawn from the foregoing is, the danger implied by the occurrence of tubercular deposit in the abdomen;—a danger great, not only absolutely, but even in comparison to that incurred by a similar condition of the lungs.

Remarks on Treatment.

In cases where tubercular consumption is to be dreaded, we often see elaborate provisions made with the design of preventing the increase of pulmonary disease; while the bowels, which are such an important item in the condition of the patient, are passed over. Invalids are sent to Madeira in order that the warm soft air may give rest to the irritated lungs; and the frequent result is that the tuberculous follicles of the intestines run into ulceration, in consequence of diarrhœa induced by the changed food and climate. They are sent moreover at all ages indiscriminately, though we see that the danger incurred in the first period of full growth is double that run during the later periods of life.[*] The not unfrequent consequence of this is that the father returns benefited, and leaves the child in a foreign grave.

In senile phthisis or in the phthisis of middle-age, I am quite ready to allow the benefit that accrues from the mild winters of Madeira, the Azores, or Cairo; but I cannot approve of the inference that such climates are equally valuable for young people. The risk of injuring the bowels counterbalances the chance of good for the lungs.

The most efficient treatment of diarrhœa from ulceration is the use of the same drugs as blunt the sensibility of sore places in the external skin. Such are chalk, bismuth, borax, acetate of lead, opium, and, last but strongest, sulphate of copper. The latter in combination with opium is, in my experience, the most powerful means we have of checking phthisical diarrhœa.

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[*] The per-centage of those attacked by this lesion in connexion with tuberculosis of the lungs, in the fatal cases at St. George's Hospital, was

from 15 to 30 years of age 33·6 per cent.
,, 30 to 45 ,, 23·8 ,,
,, 45 to 60 ,, 18·1 ,,

—"Decennium Pathologicum," chap. vi. sect. i.

The action of these drugs I take to be partly perhaps the blunting of the feeling of the sore ulcerated place (just as bismuth or chalk stays the pain of a blister), but chiefly the diminishing the exalted sensibility of the uninjured portions of the alimentary canal.

An acid gastric juice seems particularly irritating to ulcerated bowels; and I have often found an alkaline milk diet, such as previously recommended in gastric complaints most beneficial. It is not inconsistent with the administration of the above-mentioned remedies.

A (γ). *Mucous Flux of the Intestines.*

The chief local symptoms of mucous flux in the small intestines is not so much pain, as a sense of discomfort felt two or three hours after a meal. The excretion of fæces is very irregular, and is accompanied by the discharge of a quantity of glairy mucus. Sometimes this mucus is so copious as to constitute a sort of diarrhœa, but generally the stools are hard and costive, though enveloped in a slimy medium. The excreted matters vary greatly in appearance, not only in different persons but in the same individual, presenting almost every aspect except a healthy one. Sometimes they are light-coloured and abundant, of a faint, putrid smell, and containing principally unaltered food: sometimes they are dark like pitch, scanty and slimy. There is often separated from them when fluid a good deal of oily matter, probably derived from the undigested adipose tissue of the victuals. The mucus, too, itself may look like lumps of fat, being in white, opaque masses, which, however, are easily distinguished in the microscope by the presence of the usual globules of mucus. At other times it has more the appearance of macaroni, drawn out into adhesive strings.

The appetite is always very bad in intestinal mucous flux, not variable as in gastric disease, but continuously deficient during the violence of the complaint. There is also great languor and incapacity for exertion, coming on generally about an hour after food, and accompanied in some cases by an almost irresistible drowsiness, which lasts for several hours. This symptom is particularly marked in the afternoon, if the patients dine in the middle of the day, and endeavour to continue their employment afterwards. Yielding to the drowsiness and taking a siesta seem to make matters worse, for there is usually felt after such an indulgence an intense headache or giddiness, which continues longer than the symptoms would have done had the inclination to sleep been resisted. The depression of spirits is not so remarkable as the feeling of utter helplessness both of mind and body, accompanied, in persons naturally active, with a sense of shame at their unwonted apathy. These symptoms seem clearly to point to a want of supply proportioned to the requirements of the system, a want which the impeded absorption is enough to occasion.

There is, however, not much emaciation in the majority of cases. Loss by excretion is usually impeded at the same time, so that the absolute bulk of tissue is not diminished. But still the unhealthy state of the whole person is evidenced by the pale, bloated, œdematous look of the countenance. Sometimes there is a semi-jaundiced state of the skin, and sometimes attacks of complete icterus supervene from the spread of the diseased state of mucous membrane into the gall-bladder and liver.

This state of the alimentary canal is evidenced in the tongue by a pale, flabby surface not much loaded with epithelium, but wet and shiny. Sometimes it has a red base, with patches of semi-transparent membrane upon it, as if it had been burnt with a hot iron, and some fragments of skin left adherent.

When the bowels are costive and excretion is deficient, the urine is apt to be high coloured and thick, from lithate of ammonia. But except when the disorder is at the worst, it is most frequently natural, and sometimes is pale and watery.

The pain in the abdomen is very difficult to assign to any particular spot. If any one place is fixed upon, it is usually either the right hypochondrium or the neighbourhood of the navel, and sometimes the sensation seems to follow the food from the former to the latter situation. Sometimes acute attacks of spasmodic pain round the waist come on, and sometimes the skin round the navel is so sensitive that the case might be almost mistaken for one of perforation or peritonitis, were you not relieved from the fear of such a misfortune by the same having occurred before.

There is almost always distressing flatulence, which produces a feeling of suffocation, apparently from the pressure of the diaphragm upwards upon the thoracic viscera. The impediment to the motion of the heart causes palpitation, irregularity, and undefinable anxiety during day, and fearful dreams at night.

Bodily rest and sedentary occupation seem to aggravate all the subjective symptoms during the time they last; in which respect a difference is observable between intestinal and gastric flux, which is usually benefited by rest.

Intestinal mucous flux has very generally a periodic character. The patient is pretty well for a week, or a fortnight, or a month, and then the symptoms above described, or an aggravation of them, occur. A copious discharge of mucus in the stools follows, and then a temporary restoration to health. The flux of mucus seems to be of a critical character. This period in females often coincides with that of the menses, so that they are apt to trace a relationship of cause and effect between the two, and to demand of those who have paid special attention to uterine complaints that the intestines should be restored to health by the discovery of some disease in the womb. I believe the only connexion between them to be the familiar fact that *all* diseases whose tendency is to intermit and assume a periodic character, are liable to be aggravated at that time of weakness and nervous sensibility.

This periodicity is most easily observed where the mucus, collecting in the intestines, is inhabited by threadworms. The irritation excited by these creatures around the anus is often entirely unperceived except in the catamenial week, and then is excessively annoying. Nothing is more common than for women to have them in moderate quantities in the bowels, and to pass them almost daily in their ordinary fæces, without any inconvenience; but no sooner are the sensibilities of the whole body increased by the natural monthly cause, than the irritation is felt, is followed by the usual consequences, and attracts the attention of the patient.

The presence of worms in intestinal mucus is more common in mild cases than in severe. It seems as if a very abundant flux carried them away, while a more scanty secretion, by exciting no diarrhœa, retained them in their original position, and afforded a more secure home. Worms are very commonly found in the most healthy fæces, and it is only when they have been enabled to retain their position long enough to come to maturity, and leave their eggs behind them adherent to the mucous membrane, and to convert the dead, smooth slime into a writhing, irritating mass of life, that they are of any consequence.

One nearly pardons the believers in spontaneous generation on seeing these despised creatures so frequently arrive and propagate immediately that a suitable locality for colonization is afforded. But the mystery is much cleared up when we look through a microscope at a voided thread-worm, and see its body almost wholly filled with millions of eggs, minute enough to pass through most filters, and therefore probably distributed by rivers and subterranean rills to our springs and cisterns—when we find that one joint of a hundred-jointed tape-worm contains enough germs to furnish every inhabitant of the globe with an image of itself. These latent lives must be continually passing down the line of our intestines, finding only in rare instances a station to stop at.

This is an unpleasant thought, but it is some gratification to remember that we of all animals are best defended against such enemies by our possession of the sometimes despised art of cookery; it is unlikely that any eggs can live through the boiling temperature. Animals that eat raw food only can have scarcely any chronic intestinal derangement without becoming instantly filled with parasites. I remember seeing, some years ago, the inside of the boa constrictor who excited much interest by swallowing his blanket; the bowels were filled up with tape-worms, orderly arranged in long lines; and I am told that such is universally the case with boas that die in captivity. The human race, too, seems to suffer in proportion to its want of civilization. All the strange rare human parasites which fill the lists of the Entozoa have been found in Egypt, Abyssinia, and Ethiopia.* It is well known that necessity and inclination fill the stomach of the inhabitants of these regions with raw food and stagnant water, which may be supposed to be peculiarly full of ova, and against the access of which cookery guards more civilized nations.

The reason why children are more infested with worms than adults, may be traced with confidence to their greater disposition to chronic mucous secretion, especially in the intestinal canal; and among the lower classes also to the raw fruit and vegetables, and the unfiltered and unboiled water which they drink.

Itching at the anus, though the most familiarly known household sign of worms, is not an infallible sign of their presence: it is found sometimes in intestinal flux without them. It occurs, too, at night, just as the itching from worms does; so that the usual explanation of the phenomenon happening at that time—viz., the nocturnal activity of most parasitic animals—cannot be accepted; and I should rather refer it to the usual aggravation of all mucous discharges, acute or chronic, at that period.

Tenesmus also not unfrequently accompanies the copious secretion of mucus, and sometimes the continuation of these symptoms is followed by hæmorrhoids in the rectum; troublesome, however, only whilst the disorder is at its height, and disappearing when it gets better.

It is not only to worms, but to mucous flux in general, that children are more subject than adults, and females than males. This is sometimes explained in old writers by attributing it to their more phlegmatic constitution; but that is merely to argue in a circle, for the meaning of phlegmatic seems to be a greater disposition than usual to mucous discharge. It is by no means confined to pale, flabby, white-blooded and white-fibred individuals, for I have known several cases of intestinal flux, with or without worms, who were remarkably fresh-coloured and rosy previous to their illness.

The causes of this disorder are usually to be traced to continued low temperature, united to damp, or rather to a want of the occasional variation of a warm dry air;—sedentary habits, especially when united to defective air;—and in the upper classes, anxiety and intense occupation of mind in study, by impeding proper digestion of the food, are frequently joint causes. And when once the disorder has commenced, there is no more powerful aggravator of it than continued mental exertion on one subject.

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* The names of Pruner and Bilharz as collectors, in Cairo, of Entozoa, and of Bernier, Bruce, Niebuhr, and Clot Bey, as authorities on their causes, are familiar to all readers of special treatises.

I cannot find that excesses of diet, either in eating or drinking, have any effect in causing intestinal mucous flux; indeed it would appear generally as if temperance rather inclined to it. Probably it is a diet unequal to the wants of the system which best describes the usual habit in the subjects of this disorder.

Intestinal mucus flux can hardly be immediately fatal of itself, yet it reduces the body not unfrequently to such a state of anæmia, that other diseases supervene, and conduct the patient to the grave. I have known degeneration of the kidneys so induced, which finally destroyed by dropsy and diarrhœa.

Remarks on Treatment.

When the mucus has collected in considerable quantity, and excites tanesmus and piles, especially if worms are present, purgatives are required. They clear away the offending foreign matters, and open a path for other agents. But as a continued habit—as a *curative* treatment—I have always found them useless, and generally hurtful.

When purgatives are used, the more completely and effectually they clear out the bowels the better. None is so powerful as turpentine, but its excessive nauseousness makes it sometimes to be absolutely refused by patients. Next in order is calomel and jalap, four grains of the former to a scruple of the latter as a full dose, diminished in the usual proportion according to the age of the individual. These may be repeated, if required, for in few cases is one dose sufficient. And with regard to *repetition*, let it be immediate, before the mucus has had time to collect again in its original quantity.

By far the most effective means of obtaining a cure after the mucus is cleared away, are hygienic measures. Those which particularly deserve attention, are *travelling*, *riding*, and *sleep*.

Though doubtless a most valuable part of the agency of *travelling* consists in its effect on the mind—in diverting the attention from bodily ailments, and so (in the educated classes at least) removing one of the chief aggravators of the disease —yet this is by no means the whole explanation of the benefit conferred. The frequent changes of temperature which the lungs and skin experience appear of great value, acting probably through the circulation, and very simple means are usually sufficient to prevent their doing, with the good, any anticipated harm.

Some little judgment must be used with regard to the mode of travelling. Of course flying in a railway from one capital to another does the least good of any. In the great continental highways the invalid is bustled and bored, and if he deviates a mile from the beaten track he can get no digestible food; a man must have his digestion in a perfect state to enjoy the pleasures of untrodden paths. Again, in the most picturesque parts of Europe, the mountain districts of Alps, Pyrenees, Eifel, and Hartz, I have always found half my fellow travellers suffering an almost daily diarrhœa, from the peculiar nature of the water and the bread made with it. This is as injurious to a patient with intestinal flux as a purgative doctor at home; indeed, I have known several instances of the disease being actually induced in persons previously healthy, by continental mountain trips. I think therefore no directions for a tour can be so judicious in these cases as the picturesque parts of our own land: Cumberland, Wales, Devonshire, and Cornwall afford invaluable opportunities for a mixed saunter in carriage, on foot, and on horse-back, according to strength or inclination, without the risk of foreign diet.

Where a complete absence from home cannot be obtained, *riding* is often most beneficial. A rapid change in the appearance and smell of the fæces follows its use, and that is soon succeeded by restored health and strength. The gentle shaking motion probably induces more active secretion in the liver, and absorption in the intestines at the same time, by hastening the circulation; for the fœtor of putridity, which it is the business of the bile to prevent,* and the undissolved muscular fibre, which it is the business of the bowels to take up, disappear simultaneously from the stools. Though with bad external piles it is very inconvenient to ride, yet in mild cases very great relief is often obtained, and I do not think hæmorrhoidal tumours should ever contra-indicate at least a trial of horse exercise.

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* See p. 149.

The value of *sleep* is sadly under-estimated in chronic cases by medical men. They often quite omit to inquire what number of hours' rest their patients take, and thus pass over a most powerful engine of restoration of health. There is probably no disorder in which this is so important as in mucous flux of the intestines, and I have known the expedient of lying in bed till ten o'clock in the morning make treatment effective which previously had been perfectly useless.

Of medicines, the most useful are mild mercurials and iron. The mercury is best given in one or two-grain doses, with *pil. galbani comp.* night and morning, and the iron, either in pills or in small doses of wine or tincture, after the mid-day meal. Liquor potassæ, in doses of from ten minims to twenty, is useful; and chalk, with the *hydrargyrum cum cretâ*, if there is absolute diarrhœa.

The drinking of mineral water is a sort of half hygienic half medicinal mode of treatment, which does good without ou being able to contribute the case in evidence of the value o any peculiar reagent. In intestinal dyspepsia I am disposed t attribute the chief benefit to the holiday and the travelling, which I know do good, and not to the mineral springs, which in some cases I know have done harm.

A (*δ*). *Intestinal Struma.*

In children with an innate tendency to scrofula or tuberculosis, whether that tendency is directly inherited from parents affected with these lesions, or with constitutions so unhealthy as to beget a progeny thus disposed, the first symptoms usually manifest themselves in derangement of the functions of the small intestines. In spite of a ravenous appetite and usually an unrestrained gratification of it, not enough food is absorbed to nourish the body; the flesh becomes soft and flabby, the limbs thin and weak, the slightest exercise tires, and there is a dislike to the sports natural to the age.

The urine is deficient in specific gravity and in colour, depositing lithate of ammonia, nearly white, and is not unfrequently neutral or alkaline.

The stools are unnatural and irregular. The fæcal masses are very often abundant in quantity, but contain little of the proper products of excretion. They are light coloured, and tinted of a cold grey instead of a warm yellow or brown. Their bulk is made up of food entirely undigested, and in process of fœtid decay. Actual lumps of acid, coagulated, may not unfrequently be found.

The abdomen is tumid with air, but there is generally not much flatus passed *per anum;* what however does pass has the same smell of sulphuretted hydrogen that is found in the fæces.

The extremities are cold, whilst the surface of the abdomen is hot. Both have a dry harshness, disagreeable to the touch, and clearly evidencing defective action of the skin and its appendages. At irregular periods, however, as during sleep, there are profuse cold sweats, and those often resemble the partial perspirations of advanced phthisis, by being confined to the head and chest. The same sluggish condition of capillaries is shown by a variety of scabby and scurfy diseases of the skin, especially such as are easily convertible one into the other, such as *eczema*, *impetigo*, *pityriasis*, and *porrigo decalvans.* The more specific cutaneous diseases, such as true contagious *favus*, *lepra*, and the like, are not common. Obstruction of the hair follicles, producing *acne*, and *stye* in the eye, is also very often seen. The hair itself is dry, and comes off or splits at the ends, and the nails sometimes crack, and separate from the fingers. The stagnation in the external capillaries often produces a temporary œdema of the feet and ankles, especially after exercise.

The tongue is usually yellowish white, but not thickly furred or coated; through the yellow base projects generally a number of red papillæ. But the most marked feature connected with the mouth is the breath, which is faint and fœtid even in slight cases.

The abdomen is always large, not only from the gaseous contents before mentioned, but also from being loaded with a quantity of solid matter, consisting of the fæces and undigested aliments. In cases that prove fatal, the amount of these matters found in the bowels is very great.

Strumous diseases of the bony tissues, rickets, bent legs, and non-ossification of the skull, are often joined to or succeed this form of derangement in the digestive organs in children, but I cannot trace any connexion between it and the *mollities ossium* of the adult.

At a later stage, though often after an unfortunately short period of time, the abdominal glands become the seat of tubercular deposit, or the lungs are thus affected, or in more happy individuals the glands of the neck and groin become first painful, and then absolutely scrofulous. But in children not born scrofulous, I think it is rare not to find the commencement of tuberculosis marked more or less by such symptoms as have been above described.

In adults truly such is not the case, instances of such a beginning being with them the exception instead of the rule, and in persons past the prime of life and in senile phthisis never occurring as far as my experience goes. This observation is quite in accordance with what we noticed a few pages back,* concerning the greater tendency to exhibit its malignancy in the bowels which tuberculosis shows in youth, and probably is simply a manifestation of the greater activity and the more important bearing on life which the absorbent functions have during growth, than after the body is complete.

When it does occur in grown persons, there is usually more feverishness, thirst, hectic flushing, and sweats, with catarrhal attacks of stomach and bowels intervening. There is a constant sinking sensation at the pit of the stomach, only partially relieved by food, and there is usually an excessive weariness and drowsiness in the afternoon, with an uneasy depression, such as described a few pages back (page 367); in fact there is the addition of the mucous flux to the other phenomena. The skin also rarely exhibits that peculiar dryness and harshness which is remarkable in children, and is often damp and clammy.

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* See p. 365, and "Decennium Pathologicum" there cited.

The abdomen is not so tumid, though the condition of the fæces exhibits the same want of digestive power in the alimentary canal, and the same deficiency of bile, as was before observed.

In adults the tendency in strumous dyspepsia to take the form of mucous discharge is shown not only in the alimentary canal, but in the vagina in females, and in the bladder in males, so that there is leucorrhœa, sometimes of a very profuse character, and a considerable cloud of mucus in the urine. In both sexes I am inclined to think a cough with mucous expectoration sometimes precedes the deposit of tubercle in the lungs, though such an opinion is obviously very difficult of proof.

The history and the symptoms of strumous dyspepsia seem to indicate it as a disorder of the absorbent functions of the alimentary canal; but whether that disorder is the cause of tuberculosis, or whether it is only the first effect of some common cause, it would be presumptuous in the present state of pathology to affirm. The practical point to be assured of is, that it is a link, and a *leading link*, in the chain which ends in scrofula, tubercle, consumption, and marasmus.

With deranged absorption there is joined, as is always the case, deficent excretion. Such a state of things occurs in the simplest instance of insufficient absorption—viz., in want of food. And in strumous dyspepsia, therefore, one is not surprised to find a want of bile and a consequent putridity of fæces from the absence of that fluid, one of whose best ascertained duties is to act as an antiseptic.*

A knowledge of the melancholy train of events to which this form of dyspepsia is naturally a precursor, makes the prognosis always a painful one. Yet the same knowledge enables the medical man to guard against that which he fears, and I believe that in many cases he may succeed in warding it off. The principal circumstances of ill omen are the rapid increase of the symptoms, rapid emaciation, the supervention of cough, of decided irregular hard knots in the abdomen, night sweats of profuse character, and other signs of the local development of of tubercle in important viscera. The swelling of the glands in the neck or groin I can hardly call a bad sign, for if these parts become scrofulous and suppurate, in most cases the disease is so ended, and the more vital organs of the belly and chest escape. Of course it is better that the child should get well without any actual deposit of tuberculous matter at all, but yet it is a subject of congratulation when that takes place in a locality so little hurtful as these glands.

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* See p. 149.

The favourable phenomena to be desired are, the slow progress of the disorder and its amenability to treatment. When these circumstances are united, I am disposed to feel most sanguine of life getting the mastery over the tendency to deteriorate.

Remarks on Treatment.

The indications of treatment in our attempt to relieve that morbid condition of the digestive organs which constitutes the essence of this disorder, are—1. To supply such a diet as is most capable of being absorbed under the circumstances. 2. To increase the activity of the vital functions by a combination of those medicines which promote growth, and those which promote destruction.

1. What is usually called an antiphlogistic regimen—that is, a dietary so arranged that destruction shall exceed supply, is decidedly injurious in the long run to patients such as above described, and is beneficial at first only from contrast to some more injurious plan of feeding. A nutritious animalized diet, given frequently in small quantities at a time, is in my experience the best, and may almost always be commenced at any period of the disease, and persevered in throughout. Broths and flesh teas, slowly cooked at a low heat, with the addition of a few drops of hydrochloric acid, answer well where solid meat excites nausea. But they are probably not more digestible than good old mutton plainly cooked. Poultry or rabbit is less nutritious, yet is often liked as a change. Nothing takes a child's fancy so much as small birds; a lark or a blackbird will often be eaten with pleasure, when other things excite disgust; and (perhaps from the gratification of imagination) is easily digested. Fish is generally unpleasing to the palate, and always difficult of solution in the alimentary canal; no muscular fibre appears in the stools so often unaltered as this.

Milk is seldom borne well in its raw state. It turns sour, coagulates into a cheese, and cannot be again dissolved. The best way is to partially skim it, add one-third part of lime-water and some sugar, and then it will generally be found the most suitable fluid that can be designed as an ordinary drink. It may be taken with advantage at every meal.

A very palatable and useful draught to be taken the first thing in the morning, is soda-water and cream, mixed in the proportions most agreeable to the patient. Cream by itself turns rancid, but is preserved fresh by dilution and the soda.

The best vegetable food is bread and mealy potatoes, mashed with some meat gravy. A captain's biscuit, soaked in milk till pulpy, and sprinkled with sugar, makes a change.

Fruit, green vegetables, pastry, preserves, fish, stewed meat, eggs, rancid butter, should be entirely eschewed.

Alcoholic liquids do harm, by arresting those processes of life whose activity we wish to encourage. In children they should be avoided altogether; but in adults, and also in complex cases where there appears to be excess of destructive excretion or weakening discharge, or where the system has previously been habituated to their use, an exception must be made. What I have found agree best is Bordeaux wine of recent vintage, so as to be sound, free from acidity, and with the agreeable roughness of the fresh grape still remaining to act as a tonic to the mucous membranes. The second class wines are better for this purpose than the more expensive first class; to the invalid the aromatic bouquet is not worth its price, and to ripen it to perfection the wine is often kept too long in bottle. Burgundy and port come next to Bordeaux in value. Sherry and Madeira are too full of vinegar and cream of tartar shrouded under sugar, to be beneficial. Malt liquors increase so much the drowsiness and headache as to be undesirable; and distilled spirits seem to do all the harm that alcohol is capable of, and none of the good.

In this state of system sugar will often be found a very digestible, and when digestible a very useful article of diet, especially for children. Its addition to cow's milk produces a nearer resemblance to the natural nutriment of the young of our species than can otherwise be made.* Spread on bread it is usually relished much, and given quite alone, in syrup, toffee, and the like, often increases the appetite. Whether it acts as a complementary food or merely as an accessory, or both, it certainly augments the quantity of matters assimilated by the body under the circumstances of the disease now spoken of. I have had little patients affected with strumous derangement of digestion increase in weight to the extent of from two and a-half to four pounds in the first week after commencing the use of an additional four ounces* of sugar to the daily diet.

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* See pp. 202, 203.

Where there is joined to strumous mal-digestion a tendency to disease of the osseous system, to rickets or softened bones, sugar is particularly indicated by its power of arresting the metamorphosis of the bones;† and Dr. Böcker has found great advantage from joining to it an additional quantity of phosphate of lime to that which is ordinarily found in a bread and meat diet.‡ But I am now transgressing the limits of dietetics, and passing into the domain of medicine,—if in point of fact they *have* limits and separate domains.

2. The drug which comes nearest to an article of diet, and which may also take its place as a promoter of the vital function of growth as a medicine, is cod liver oil. The principal reason that can be alleged for calling sugar a food and the oil a physic is, that the first is nice, and the second is nasty.

A person who takes the usual *haustus ter die sumendus* of oil, gets daily three additional meals of a light, sparing, digestible character; and profits accordingly, if no untoward circumstances stand in the way, in nervous, mucous, muscular, and bony tissues. I believe these additional meals to be of great importance to patients where we want to increase the quantity of matter absorbed; and I therefore object to the advice sometimes given, to administer cod liver oil with or after food. There is by this advice sacrificed one main advantage, to secure which I usually order hours for taking the oil to be selected as far as possible removed from the ordinary meal-time. I find also that it is a good plan to make the dose still more of a separate meal, by washing it down with a wine-glass of half-and-half milk and lime-water, or milk and soda-water, with a mouthful of biscuit, so as to neutralise any rancidity in the oil, and add some more matter for absorption.*

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* A quantity larger than is necessary or desirable, but given in the instances above mentioned for the sake of trial.

† See pp. 199–203.

‡ Böcker's *Beitrage zur Heilkunde*, i. 123–186.

This drug is often of great use in the cases we are considering, but is not borne in the large, almost unlimited doses which can be administered with advantage in pulmonary consumption. A teaspoonful twice a day, washed down with alkalinized milk as above described, is usually the quantity that does most good. The test of benefit received is an improvement in the quality of the stools, or an increase in the weight of the whole body.

Steel is more purely a medicine—it cannot take the place of a meal. The best time for it is after eating, and the most agreeable of the beneficial forms is steel wine. But I have found the drug in its simple metallic form sometimes agree better, especially the finely levigated *fer porphyrisée* of the French Pharmacopœia. Chalybeate waters have the disadvantage of not being convenient to take after meals as above recommended.

I do not think vegetable tonics seem to do much good, except for the temporary purpose of giving an appetite or making a change from other remedies.

At the same time with these medicines, given with the design of increasing the building and formative functions, there should be administered those which augment the corresponding powers that make up life between them,—the increasers of metamorphosis. A full allowance of water and salt in the diet is desirable, and sea-bathing is beneficial on the same grounds. Iodine is also exceedingly useful, and the benefit received will be observed to be in close proportion as, during the use of the drug, the metamorphosed matter excreted by the liver and intestines, in the fæces resumes its natural quantity and appearance. Mercury, the most powerful increaser of metamorphosis that we are in possession of, may also be given, but with caution that it does not outrun the tonics we are administering, and cause destruction to exceed growth. The best form in which to give it is *hydrargyrum cum cretâ* in one or two-grain doses, with double the quantity of sesquicarbonate of soda, and a grain of powdered rhubarb. Directly the desired change in the appearance of the stools follows, the powders should be left off.

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* The best cover for the taste of all fish-oil is orange-peel tea. It may be made of a strength suited to taste in a clean crockery tea-pot, and when cold the oil floated in a globule on a small cup of it. If at the same time a chip of the orange-peel is chewed before and after the dose, the most sensitive patient soon overcomes the dislike to the medicine. The peel of course should be *druggist's*, not *confectioner's*, orange-peel.

Nitre and other neutral salines have much the same alterative action as mercury, except that it is more peculiarly exhibited by the kidneys. If the urine is scanty, high coloured, or thick, they are desirable, and perhaps may take the place of mercurials in other cases without loss of benefit.

In adult cases it may be proper to recommend a course of foreign mineral waters, for the change of air and scene, and the amusement for the mind which such a treatment involves cannot but be beneficial. A series of the Spa springs is perhaps as compact a course as could be taken, commencing with the Groesbeck twice a-day after meals, and then taking the Geronstere at its source, accompanied by drives through the oak woods, and social saunterings in the avenue. The place is intolerable to the energetic holiday maker, but is pleasant to the lounging invalid.

The mineral waters to be avoided, and which will be most likely to disappoint the trier, are strong salines and strong chalybeates: neither are suitable in their integrity, though dilute editions of both are capable of benefit. Let therefore our travelling patients, with complaints approaching to what has been described, keep clear of Carlsbad, Ems, Fachingen, Püllma, and the like, or any of the well-known chalybeates, Hartfell, Moffat, or Pouhon of Spa.*

Mineral waters do not however suit children well. The patients are apt to get weakened by diarrhœa, and in proportion to adults, benefit much less by change of scene and more by change of air. So that the sea-side is decidedly preferable. Exerything to the youthful mind is new, and the shells and pebbles on the shore are to them what unaccustomed ways of life and travelling are to the adult.

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* When sending patients on their travels to natural mineral waters, it is quite as necessary, if not more necessary, to tell them what to avoid as what to drink. For according to local guide books, each water cures everything, and the temptation to "try a course" is very great.

Friction has been too much neglected as a remedy, probably on account of the trouble it entails. It is of use where the abdomen is large and where the cutaneous circulation is sluggish; and in the case of rich patients, to whom an extra servant is no object, ought to be practised.

Gentle rubbing with a soft hand, guarded with flour, starch, or violet powder, is the best mode of applying it. It may advantageously take the place of bathing, where that causes chilliness, pain in the abdomen, or is otherwise contra-indicated.

PART B.—*Defective Excretion.*

" *Biliousness.*"

The evidence of the excretive functions of the small intestines and their appendages being deficient, is afforded by the presence in the blood (as seen in the skin) of the coloured matters which ought to be thus ejected from the system, and at the same time by the scanty quantity of these constituents in the fæces. What proportion of these fæculent matters comes from the liver we have not yet the power of asserting, but the main point, that they come from portal blood, we are justified in taking for granted; so that the solution of the former question is of less importance.

That a great deal of the deeper colour of fæces is due to bile, is familiar to us from the phenomenon of jaundice in obstructed gall-ducts. But the fæces in these cases by no means consist entirely of undigested food; there is in them a great proportion of a yellowish-grey granular matter, which appears also in the healthy state; and which often, even in complete occlusion of the passage from the liver, still makes up a bulky mass.

In deficiency, therefore, of the excretive powers of the intestines generally (*vulgo* "biliousness"), there is a different substance retained than is the case when local lesion of the liver obstructs the evacuation of bile alone. There is partial retention of the whole matters to be excreted from these quarters instead of a complete retention of one constituent.

Hence the colours communicated to the skin are different; *in local disease of the liver or gall-bladder* there is jaundice of the external surface, accompanied by clay-coloured stools, whenever the flow of bile is impeded, and no change of colour so long as it is free; *in general defective excretion from the intestines* there is a dinginess and darkness of complexion, but none of the yellow green of jaundice, and the stools are scanty but not clay-coloured.

The skin gets greasy and opaque, the countenance sometimes puffy and bloated, sometimes thin and pale, and the lower eyelid especially sallow and discoloured. The sebaceous follicles on the alæ nasi are stopped up with black matter.

There is in the patients thus affected seldom any decided emaciation, nor is there always even loss of muscular power: but still there is great sluggishness of body and apathy of mind, and often a miserable want of decision and energy. Digestion is accompanied by a good deal of discomfort and flatulence, but rarely by actual pain; and the distress does not begin till several hours after eating, so as to be with difficulty referred to any particular meal.

"Biliousness" is often associated with intestinal mucus flux, either as cause or consequence, sometimes also it is joined to a strumous habit of body; in both of these instances defective absorption and defective excretion being physiologically connected together. It alters in some degree the indications of treatment, but very little the symptoms, except as far as the colour of the skin is concerned.

Where there is no mucous flux the appetite in general does not suffer, and as the ingestion of food gives no immediate pain the patients often indulge largely in eating, and pronounce the first period after a meal their most comfortable time. Alcohol however gives warning of the injury done, by causing, even when taken in moderation, a more than usual unsteadiness of gait and giddiness; it is therefore usually abstained from by choice. Even eating will sometimes cause this derangement of the nervous system, and I have known a patient declare that excess of animal food produced the symptoms of ordinary drunkenness.

Sometimes attacks of jaundice will intervene, and sometimes acute spasmodic pain in the bowels and flatulent colic, but these are by no means the rule.

In every case of arrested intestinal excretion, the bowels are costive, and the stools remarkably scanty, usually dark, hard, and dry; the urine from time to time deposits copiously lithate of ammonia, and is often dark coloured, but not otherwise unnatural.

Loss of excretive power in the intestines in some cases leads to a remarkable form of paralysis. The muscles of the lower extremities gradually, by almost imperceptible degrees in general, lose the power of progression. It is not so much that they cannot move, but that they move with excessive slowness; and they are not, as in ordinary paralysis, incapable of sustaining the body in the upright posture. The patients can stand pretty well, but cannot go. There is not moreover any deficiency of sensation. Sometimes the derangements of digestion, gastric and intestinal, which had preceded this paralysis, vanish on its supervention, but this is not always the case, and is certainly difficult of explanation, when ascertained to be really the fact.

This partial paralysis is most frequently observed in Europeans returned from an Indian climate, and I have understood is by no means uncommon in Mexico and South America. But I have seen it in those who had never left England, and its greater frequency in the victims of temperature, is probably simply occasioned by the familiar fact of the greater frequency of its true cause—viz., the loss of intestinal digestion in those parties.

The mistake is frequently made of attributing the loss of power in the lower extremities above described, to lesion of the spinal marrow; and there certainly is much difficulty in drawing a distinct line of demarcation between the cases now being considered and those where the cord is actually diseased. Yet the diagnosis is of the utmost importance to the patient and to the good fame of the medical man; for while spinal softening, tumour, or inflammation is an injury admitting of palliation only and not of cure, and usually destroys life at no distant period, the paralysis now in question not only frequently, but generally, is amenable to rational treatment, and seldom, even remotely, shortens the days. The most marked difference between the two lies in the history. This form of paraplegia comes on exceedingly gradually, so that it is very difficult for the patient to date, not only the commencement of the disorder, but any period at which it has got worse; while spinal disease has, if not a sudden beginning, yet always sudden aggravations from time to time, and after each aggravation the patient is decidedly worse than at any previous day. The history also, and the present symptoms of deficient intestinal excretion, can guide the practitioner to a diagnosis.

Another curable sort of paraplegia, which arises from exposure to cold and wet, is easily distinguished by being traceable to the cause, of which a distinct account can always be given.

As above stated, "biliousness," or deficiency of intestinal excretion, is most common in those who have resided in a climate hotter than their hereditary one. But it is by no means confined to them, as has been already remarked concerning its cognate, paralysis. It is sometimes associated with disease of the liver, and one way it proves fatal is by degeneration of this organ, and in tropical climates also by abscess. Many, however, both Indian and English patients, after suffering for years from biliousness, die of other diseases, say of the lungs or kidneys, and exhibit livers not appreciably altered from a healthy appearance.

As some victims of the above-named state are to be found in all classes of persons who have returned from the East, whatever their mode of life has been, it is to be presumed that the climate may produce it, independently of Anglo-Indian habits. It is due probably to a long-continued congestion of the portal system annihilating the activity of life in the intestinal mucous membrane; and this congestion may be traced to the absence of the healthy stimulus of alternations of moderate cold and wet to the external skin.

The tendency to congestion of the portal system is shown by the frequency of bleeding piles among Europeans in India; and the relation which this congestion bears to intestinal complaints is evidenced by the relief which the natural hæmorrhage gives, and the observation that it often acts as a safety valve, and prevents further mischief.

In addition to the climate, it is certain that Indo-European habits have a great influence in giving rise to the state of system now spoken of. The removal at an early age from the restraint of friends and of the moral influences of a reserved tone of society, together with the possession of a larger income than is usual in the class of life whence they are taken, are a terrible ordeal, and it is really creditable to our countrymen that Indian manners are not worse. Still, compared with what we see at home among the upper and middle ranks, there is a great amount of careless sluggishness and uncontrolled indulgence, even among those who are not absolutely vicious. And by this the bad effects of the climate on the portal system is at least doubled. According to what I hear from unprejudiced persons who have mixed in society in those countries, over-eating, in proportion to the requirements of the system, is quite as much a source of evil as over-drinking, and at the present time is the most insidious and usually unsuspected enemy to the constitution. This is often passed over by Indian practitioners at home, because in their day intoxication was a more predominant vice throughout the civilized world than it is now.

Remarks on Treatment.

In incipient chronic derangements of the intestinal digestion, the application of leeches to the anus is a remedy too little employed in this country. It is naturally indicated by the relief and preservative influence of a sanguineous hæmorrhoidal discharge, and this following of nature will be rarely found to disappoint the patient in temperate climates. Never having crossed the line, I cannot know all the circumstances which might be against or in favour of the expedient under tropical skies; but unless there are any serious impediments to its use, it seems to offer the best chance of preserving health in Europeans disposed to intestinal congestion.

In the application of the remedy it must be remembered that it is to be antagonistic to a slowly acting alterative disease, and must therefore be used in a steady alterative manner. Two or three leeches at night, followed by a tepid sit-bath, should be the maximum dose; but it may be repeated every night or every other night for a fortnight or three weeks together, if the general strength and the making of wholesome blood be at the same time promoted by an easily digestible diet. It is remarkable how the freshness of complexion and the transparency of the skin will gradually return, and often weight be gained, during the employment of this practice.

Partial views of the physiological action of water on the animal frame* might induce the hope that hydropathy would be found a very potent engine for restoration to health in deficient intestinal excretion. Such however does not appear to be the case. Some cases are benefited, and probably the fine air and pleasant sites of most hydropathic establishments contribute in no small measure to the favourable result:† but some I have known to be severely injured by the treatment adopted; indeed, it has seemed to bring on the peculiar paralysis noticed as appertaining to this complaint. Only in very special cases would I recommend it, and then with great caution.

The probability is that the effect of water in excess is too violent and sudden, and depresses too much the nutrition of the nervous system, when it is employed in sufficient strength to unload the portal circulation; and if employed in a strength not sufficient for that purpose, it is unequal to the occasion.

A more suitable mode, of augmenting the activity of metamorphosis, as required in this state, is the use of saline mineral waters. A saline, at first alone and then mixed with a chalybeate, both of moderate strength, accomplishes the purpose. The choice of the particular spring must depend upon a variety of circumstances in each case, and perhaps the only general rules are, that excess of alkali in the water is not so beneficial here as in most derangements of digestion, and that sulphureous gases should be avoided.

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* See p. 181.

† Our forefathers were not nearly so wise in this respect as the present generation. The only old hydropathic establishment I know of is the one attached to the convent of Pfeffers in the Canton of the Grisons, memorable as having been patronized by Martin Luther, and as being supplied with that rarity, perfectly pure water, hot, and yet impregnated with carbonic acid. A more gloomy hole than the sunless gorge where it is placed can scarce be imagined.

CHAPTER VI.

MORBID STATES OF PANCREAS.

The probability expressed in the corresponding chapter of the First Book (page 124), that the pancreas is merely an additional salivary gland, and that its duties therefore are simply a reserve against the frequent deficiencies of similar glands more exposed to accidental arrests, is a sufficient reason for not attributing any peculiar disorders to its morbid states. It is not at all uncommon to find it destroyed by cancer, and sometimes ulcers of the stomach eat into it and cause abscess;[*] yet no special derangement of digestion has been remarked. Reasons have been already given in the physiological review of the subject for not attributing any great value to observations which referred to it deficient absorption of oleaginous substances, and even if these cases were important in a scientific point of view, their great rarity deprives them of practical importance.

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[*] During ten years at St. George's Hospital, the pancreas was found, in 2161 autopsies :—

Affected with cancer	five times
" tubercle	once
Degenerated into a cyst	once
Eaten into by a gastric ulcer	three times

See *Index to Morbid Appearances after Death in Fatal Cases at St. George's Hospital, from January* 1, 1841, *to December* 31, 1850. Compiled by T. K. Chambers, M.D. (MS.)

CHAPTER VII.

MORBID STATES OF LIVER AFFECTING DIGESTION.

THE liver has been such a well known organ from the earliest times, and has such an obviously ascertainable seat in the abdomen, that it was one of the first viscera accused of being diseased. Since nomenclature and diagnosis have been yearly growing more exact, its name is less frequently in the mouths of medical men; and we are able to refer many symptoms, formerly considered as belonging to it, either to general states or to other parts of the body. Disorders of the bowels, stomach, colon, kidneys, and heart have been unquestionably considered as hepatic; and even the chest has not escaped, for I have many times seen both effusion in the pleura and tubercular disease in the right lung, called inflammation of the liver.

But still, with all such instances subtracted, lesion of this viscus is by no means uncommon. In 2161 fatal cases examined in ten years at St. George's Hospital there were found—

Abscesses (not pyæmic) . . .	4	times
" (pyæmic)	21	"
Acute inflammation, without abscess	1	"
Hydatids	11	"
Serous cysts	3	"
Tubercle	24	"
Cancer	47	"
Fibrous yellow elastic masses .	3	"
Chronic degeneration, producing structural change of appearance on section,		
(1) with enlargement . . .	161	times
(2) with diminution	75	"
(3) without change of size .	80	"

Puckering, thickening, or similar change of peritoneal coat, only without apparent change of the interior	128 times
Gall stones	24[*] „

It would be diverging too long from the object of this volume to analyse these cases. The list is sufficient to show that any common symptoms arising from hepatic disease could hardly escape notice. The general result is, that as a consequence of—

peritoneal lesions, there is *pain in the side*;—
large gall-ducts, obstructed, there is *jaundice*;—
universal equal degeneration, there is *ascites*.[†]

The appearance and other physical qualities of the bile are not appreciably altered by any hepatic disease consistent with life. As long as it gets into the intestines it colours the stools with its natural tint, and where it does not get into the intestines and the fæces are consequently light coloured, it is found of normal aspect behind the point of obstruction. The derangements of the constitution arising from hepatic disease appear to be exhibited in the sanguineous rather than the digestive system of functions, and the duties of the liver as a depurative organ seem to be those whose loss chiefly entails danger to life.

The principal dangerous symptoms arising from hepatic lesions, are diseases of the heart, dropsy, ascites, bloody vomiting, bloody discharges from the bowels, hæmorrhoids, &c.; and these disorders of the circulation are so injurious that they are apt to destroy life before the change of structure in the liver has proceeded far enough to stop the formation of bile, and so to arrest the function which it fulfils in digestion.

Still, in hepatic lesions, especially in general degeneration of the substance, there must be a diminution in the quantity of bile daily formed. If four pounds of healthy liver, consisting mainly of bile-making cells, secretes daily about its own weight of fluid,* it is not likely that when the weight is reduced to half, and a great deal of that made up of thickened Glisson's capsule, fibrinous deposit, and fat (as is the case in degeneration), that the same quantity should continue to flow from it: although, as before remarked, the physical properties of what does flow, so far as observable, are not altered. The derangements of digestion consequent on this state of things are very much what physiology would lead us to expect. The digestion of meat is but little affected, nor is the appetite taken away; but if any excess of albuminoid substances are taken, the antiseptic properties of the bile are missed,† and fœtid decomposition takes place, giving the stools a cadaverous smell and filling the bowels with poisonous sulphuretted hydrogen.

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[*] MS. Index before quoted.

[†] There is sometimes also in hepatic lesion a singular absence of symptoms altogether. A young woman convalescent from typhoid fever under my care, last year, at St. Mary's, died suddenly in a fainting fit, caused by rising to make water contrary to orders. There was found in the liver an abscess containing a pint and a half of pus, yet not the slightest indication of this existed before death, nor was the improvement of appetite usual to convalescence at all retarded.

It is also to be observed that where there is degeneration of an important extent of liver, emaciation usually occurs. And the emaciation is often found to be accompanied by less loss of strength than where it exists in an equal degree as a consequence of lowering complaints, such as fever or pulmonary consumption. The muscular tissues seem less affected than the adipose, so that the patient, though extremely lean, is not so much prostrated as a phthisical person who has lost flesh to a minor amount.

This phenomenon may fairly be considered to depend on the diminished power to absorb the required quantity of oleaginous aliments which a partial deficiency of bile must occasion.‡ From a similar cause butter and oil, if taken mixed up with albuminous food, are apt to become rancid, and occasion a good deal of distress; while at the same time there are cases which can take cod liver oil as a tonic with great benefit.

Remarks on Treatment.

In lesions of the liver, plain lean meat can generally be pretty well digested. When fœtor of the fæces shows decomposition in the alimentary canal, the quantity may be diminished; and what I think of some importance, the intervals between the periods when albuminous food is taken may be lengthened, so that the last ingested quantity may be out of the bowels before the next comes in. Meat every other day may often be digested, when to eat it every day causes distress. Vegetable food need not be abstained from.

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* See pp. 35 and 138.

† See p. 149.

‡ See p. 145 et seq.

Fat or butter should not be taken with albuminous food; but alone, at a time distant from meals, can often be digested, and then cannot but be advantageous. The apparent inconsistency of telling a patient to abstain from the ordinary modes of taking oleaginous matters at the same time as we recommend him cod liver oil, should be explained to him.

A considerable quantity of fluid should be drank to supply the deficiency of the watery constituents of the bile, and to aid also in preventing that congestion of the portal system which the obstruction of the bloodvessels occasions. But into the further treatment of diseases of the liver, indicated principally by their influence on the circulation and depuration of blood, this volume is not the place to enter, the introduction of them here arising only out of their influence on digestion.

CHAPTER VIII.

MORBID STATES OF COLON AFFECTING DIGESTION.

Atonic Constipation.

OFTEN joined to other disorders of the stomach and bowels, and sometimes alone, without any other function being deranged, there is a sort of constipation which appears to depend on the state of the colon itself. The solid matter of the fæces is scanty or natural in quantity, as the case may be, but they are excreted at long, irregular intervals, and with great labour to the abdominal muscles, and painful distension of the anal sphincter. When fæcal matter is excreted, it is dark and lumpy, sometimes in little round lumps, like sheep's dung, always friable and dry. There is often a good deal of tenesmus and ineffectual straining, by which only a little mucus is discharged for many days; then follows a quantity of fæces such as above described; and then a sort of diarrhœa; and on that ceasing, the former state of costiveness returns worse than ever.

There is an indisposition in the colon to respond not only to the physiological stimuli, but also to artificial ones. Purgative drugs require much longer time to act on these patients than on others, their effect sometimes not appearing till a lapse of twenty hours, or even more, has occurred. Practitioners ignorant of this circumstance often do harm by pouring in augmented doses, when all that is wanted is a little patience to wait till the ordinary quantity has time to exert its influence.

Sometimes in thin persons a distinct hardness may be felt along the whole course of the colon, and in the cæcum and sigmoid flexure dullness on percussion. In various parts also of the situation of that bowel, there is sometimes a dull softness felt on deep continued pressure.

In incipient cases there is often no very marked derangement of the general health, but the appetite is bad, and there is a want of the natural vigour of mind and body. There is incapacity for continued attention, so that a merchant, for example, will tell you that he cannot add up his totals beyond a certain figure without setting down the sum in the middle.

Then there comes on an increase of the mental susceptibility to sudden noises or any similar impression, palpitations of the heart, and causeless fears, nightmare, frequent headaches, nervous perspirations, attended with deadly chills, and in women hysteria. There is also in women generally a suppression of the catamenia, and more in that sex than in males, pain in making water, and a sort of spasmodic stricture of the urethra.

The disorder is not long before it causes the whole intestinal canal to sympathize, and then the mouth gets foul; the tongue loaded and swollen; the gums pale, and covered with a white film; there is a nauseous metallic taste, and the breath is fœtid, of a faint or even fæculent odour.

The urine is mostly dark coloured and scanty; but when the nervous symptoms begin to predominate, as is not unusual in long protracted cases, and in women, it gets limpid and light. The specific gravity is in both cases less than natural; in the first, where from its concentration it ought to be high, it is usually the same as that of ordinary health; in the latter it is abnormally low: it exhibits therefore in both an evidence of deficient metamorphosis.

The circulation is always sluggish, and gets more and more so the longer the disease has lasted, showing that this sluggishness and tendency to congestion is a consequence, at least in part if not entirely, of the ailment, and not a cause thereof. The pulse is therefore apt in some cases to acquire an unnatural slowness, in others it remains natural during absence of excitement, while it is easily quickened by mental causes; but in all there is a cold, clammy skin, and the extremities easily become chilly and dead, the lips and nails livid. These indications of disorder of the circulating vessels are not inconsistent with a fixed colour in the cheeks, which gives a false notion of health, and is not uncommon in delicate skinned individuals.

The symptoms that most commonly attract the chief attention of the patients, and bring them to a medical man, are referable to the disordered functions of the brain and nervous system. Headache, giddiness, faintness, nervousness, and stupidity are the main complaints. The headache is of an intermittent character, sometimes very severe in the morning, and getting better as the day advances; sometimes occurring in the evening, and being worse after any unusual exertion or excitement. The giddiness is accompanied by buzzing in the ears and pulsation of the temples, so that patients sometimes fancy they are going to have an apoplectic fit. The faintness sometimes ends in vomiting; sometimes (especially in females) it assumes a convulsive character, and passes into hysteria; as do also the flutter, agitation, and tremor so very generally concomitant on this morbid state. Stupidity is more usual among males; but even among them, when the perception of nervousness is denied, a peculiar tremor of the facial and buccal muscles will often indicate its existence to a medical man.

These symptoms are often accompanied by unaccountable pains in various parts, which exhibit their neuralgic character both in their intermittence and in the absence of the phenomena which would be manifested if they arose in such severity from any other cause.

A very common consequence of atony of the colon is the formation of piles; but unlike the disorder of the small intestines last discussed, it does not appear to be at all relieved by them, indeed, I doubt whether it is not aggravated both by their formation and by their bleeding.

Another consequence is "biliousness," or extension of the atony to the small intestines, indicated by an increased sallowness and darkness of complexion, an increased scantiness of the stools, and sometimes by their light colour,—in fact by the supervention of the symptoms of constipation arising from the small intestines described in the last chapter.

It must not be supposed that all cases of infrequent evacuation of the bowels are constipation. In some persons that is diarrhœa, which is the opposite in others—the daily evacuation, which a commodious custom has made us consider natural, would be a "*morbid frequency*" to a patient whose habit in health is to go to stool every second or third day, and "*constipation*" to one whose bowels are acted on naturally thrice daily.

In the anatomical museum at Christ Church, Oxford, there is the colon of a female whose bowels in health were open only once a fortnight: it is of gigantic thickness and strength, so as to support without distress the great column of fæces it must have held. Instances are familiar to all of the opposite extreme, where the colon refuses to contain with comfort the relics of more than a single meal. As a general rule, that only can be called constipation which has evil consequences arising from it.

The period of life when atony of the colon most frequently occurs is from puberty to about forty, a time when the capacity of the body for activity and the opportunities for it are the greatest; yet the disorder is by no means dependent on bodily exertion—indeed it seems to arise from just the opposite cause, viz., sedentary habits at a time when nature indicates the contrary. The classes amongst whom it is oftenest found are those whose occupation leads to the adoption of some constrained attitude—tailors, shoemakers, needlewomen, weavers, miners; who suffer very much in the order in which they are placed above. Then rank those who are merely sedentary, without placing the body in any unnatural posture,—milliners, governesses, nuns, lazy women of fashion and wealth, literati, prosperous lawyers, booksellers' hacks, in fact, all who take too little exercise, whatever their mental occupation may be. I am disposed to think however that the evil of sedentary habits is very much increased in all the cases mentioned, when bad ventilation superadds the noxious influence of impure air; for certainly the greatest number of patients come from close low workshops, where many are crowded together, and the defect of artificial warmth prevents the windows being opened. So that the barrister in full practice, though he may perhaps sit in his chair longer than the tailor and seamstress who make his coat and shirts, yet is less frequently laid up by the disorders we are now considering; and the fine lady, however sluggish, is more likely to escape than her milliner. The occupations where sedentariness is most noxious are those where a high unvarying temperature is required to be kept up by the nature of the work, and where the draughts and change necessary to the workman's health are injurious to the article produced. Such are some kinds of weaving, silk throwing, and winding, &c.

When there is a disposition in the colon to be atonic, this disposition is much aggravated, and sometimes first made evident, by some kinds of diet more than others. It is a fallacy to suppose that indigestible articles of food "irritate," as it is called, the bowels—that is, are passed on quicker than more easily soluble substances. The contrary is the case; and as a general rule the gradual and regular transmission of the alimentary mass is in direct proportion to the readiness and completeness with which its solution in the stomach and intestines is accomplished. No sort of food is so apt to be followed by constipation in atonic persons as that which contains a large proportion of matter incapable of being acted upon by the digestive juices, such, for example, as the stones and husks of fruit, where the woody fibre and various forms of cellulose are purely foreign substances; stringy and half-boiled vegetables, in which, besides cellulose, there is unbroken starch, an equally impracticable body; gum also, and gelatine in jellies and pastry, may perhaps be included under the same category;* and in general all substances capable of being squeezed together into an impenetrable mass, such as puff pastry and new bread, all of which are liable to cause constipation in atonic constitutions, instead of the "disturbance of the bowels" which the patients are apt to anticipate.

Remarks on Treatment.

A strong argument in favour of the view taken in the foregoing pages of the symptoms described being dependent on the unemptied state of the colon, in contradistinction to that which would count the condition of the gut as merely one of the symptoms, is derived from the fact that the discomforts are always alleviated and sometimes entirely removed by a mere mechanical clearance of the retained fæces. This, then, is the first thing to be done. Frequent enamata of warm water or gruel accomplish the business with least discomfort to the patient, and with least fear of doing harm; but their action is much more effectual and complete if accompanied at the same time with moderate doses of purgatives. A small quantity of senna and jalap, such as alone would simply be absorbed and gripe without evacuating the abdomen, will be taught what is expected of it by a glister being given an hour or two afterwards. Rhubarb acts well, but it makes some persons sick. The neutral salts, if administered alone, are apt to produce watery stools without washing out the retained fæces, and hence give useless distress, but with senna, as the ordinary "black draught," they are useful. In all cases the remark made about the slow action of purgatives on these patients must not be forgotten, and patience must be exercised before stronger drugs are administered. It is often stated in praise of certain articles of the materia medica, such as croton oil for instance, that they act *rapidly.* Doubtless this is sometimes important, but in the cases we are considering a higher commendation is that of acting *completely;* and I would reckon the value of a purgative by the weight of solid fæces it brought away, and not by the quickness or the number of the stools.

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* See page 213 et seq.

The next indication is to restore to the colon its tonic action. Though merely an artificial substitute for natural stimuli, purgatives cannot well be done without. If given at regular intervals they appear to get the system into a habit of evacuation which it continues after they have ceased to be administered. Mild, slowly-acting drugs are best for this purpose, and they should be taken at a certain time every evening, so as to produce a motion early in the following day. The *Aloes and myrrh* pill, in doses of from five to fifteen grains, or more if required, is perhaps as good a combination of tonic and purgative as can be selected.

In respect of diet, reference may be made to the observations at page 398 concerning the dietary most likely to cause or aggravate constipation in atonic cases: an avoidance of these, and a selection of articles easily soluble in the digestive juices and capable of affording the required nutriment to the weakened system, is evidently indicated.

Mercury is not advisable where the atony is confined to the colon; it reduces still further the tone of the system, and though temporarily it may act as a convenient purgative, yet in the end the use of it aggravates the complaint, and sometimes renders it absolutely incurable.

Among hygienic measures, travelling should be mentioned, because though it is often advised, disappointment is often expressed concerning the result. In general it does not exhibit its beneficial influence till after a return to home and the usual habits: *during* the travelling the constipation is *apparently* increased; that is to say, the stools become more infrequent. Now if the patient is induced by this circumstance to augment the doses of purgatives, harm is done, and the benefit of the travelling is done away with. But if, being forewarned by his physician of this probable event, he leaves matters alone, and satisfied with recovering strength patiently completes the tour, he will find shortly after his return that the action of the colon becomes much more regular and powerful.

CHAPTER IX.

FLATULENCE.

THE collection in the intestinal canal of a greater quantity of air than is consistent with the comfort of the individual, may arise from one or more of the undernamed causes:

1st. Portions of the external atmosphere may be swallowed with or without the ingested food.

Some persons have an irritation of the œsophagus, or perhaps simply a bad habit, contracted during some previous irritation of the part, of sucking down portions of air in the same manner that crib-biting horses do from a similar morbid sensation. In these instances the gas collects in the stomach only, and is thrown up by eructation; and I am disposed to think that swallowed air rarely, if ever, passes the pylorus, except in small quantities normally mixed with the food. This form of flatulence may be recognised by the slight odour or taste of the gas rejected, and by its coming from the stomach, as above described.

2ndly. The gas may be secreted from the mucous membrane of the bowel, as is shown by the experiment quoted at page 156, in the former part of this volume.

This is most likely to happen in the small intestines, through which so much blood loaded with air is circulated; and then most probably the flatus will be constituted principally of carbonic acid, with which the sanguineous portal system is charged. It will be discharged *per anum*, and have more or less of the scent of healthy fæces.

This slightly fœtid flatulence is the rule in hysterical and anæmic subjects, and is a proof of disorder of the circulating and pulmonary systems, rather than of the alimentary canal. It appears partly, and in some cases almost wholly, dependent on nervous and mental influence, nay sometimes seems as if it was really voluntary, so affected is it by the state of the will and the passions.

As there is every reason to believe in a circulation of gases equally with fluids through the walls of mucous membranes—to think that in the normal state they are given out and taken up in equal proportion, so as to collect only in inappreciable and requisite quantity—it is obvious that an arrest of the physiological action of absorption will cause the abnormal collection of gases in the hollow viscera, as well as an excess of secretion in those parts. Such a theory is more consistent with pathological science than the supposition of over-secretion.

This form of flatulence, then, is easily seen to be connected with a debilitated constitution and a relaxed muscular fibre: and for that reason the contractile coat of the alimentary canal is apt at the same time to be dilated, and the augmented area of the bowel to increase the evil it is associated with. These cases are usually the most obstinate.

In cases of inflammation of the bowels, especially peritoneal inflammation, it would appear to be arrest of absorption, conjoined to paralysis of muscular fibre, which causes the excessive collection of gas, marking an advanced stage of the disorder. The *flatus* here is rarely let off by the bowels: when it does escape, it is not fœtid; and in cured cases it is readily absorbed, seeming to show that it is merely carbonic acid arrested in the course of circulation.

Joined with the collection of gas there is often a defective absorption of fluids,* so that in chronic cases the liquids taken as drinks cause distress, by bubbling and rumbling about in the abnormally large space assigned to them. Hence the noises in the swelled abdomens of anæmic persons

3rdly. The decomposition of articles of food may give rise to the collection of gases not of a nature fitted for being absorbed, such as sulphuretted hydrogen, ammonia, hydrosulphate of ammonia, and an excess of carbonic acid over and above the normal quantity.

This happens very rapidly where the digestion is defective, and also where a sufficiency of bile is not poured out, as is satisfactorily shown by the experiments of Drs. Bidder and Schmidt on animals, and by medical observation of the human subject.

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* See before, page 255.

The gases which collect from this cause are, on being expelled upwards or downwards, excessively fœtid, even in small quantities; so that the origin of the flatulence from defective digestion is readily recognised. It also causes more discomfort than the others during the time it lasts; gripings, nausea, faintings, being not infrequent accompaniments; a circumstance which may be rationally referred to the poisonous nature of the gases evolved.

Thus we have three forms of flatulence:

(1) *Swallowed air*,
(2) *Secreted air*,
(3) *Air of decomposition*,

all capable of recognition by the marks above noted, and occuring in different cases. They are found doubtless very often united, yet it is rare not to observe a predominance of one or the other; and that predominance may give a useful hint as to the treatment.

(1) The best *special* treatment for the trick of air-swallowing, I have found to be emetics; but at the same there will be often found some other deficiency in the working order of the œsophagus or stomach which will require to be rectified before a cure is obtained. It is often associated with the somewhat similar habit of "human rumination," or the bringing up from time to time of portions of food and swallowing them again. This also is best treated by emetics. Still, in both instances moral means should be tried as well as physical, for there is no doubt but that the will has a great influence over such actions.

But in elderly persons sometimes the air collects in such quantities as to cause a paralysis of the muscular coat of the stomach, joined to a spasm of the œsophagus, which prevents its being let off by eructation. This sometimes impedes the action of the heart and diaphragm, causes fainting, and might easily be conceived to be fatal. Mustard poultices should be, in those dangerous cases, applied to the pit of the stomach, and stimulants, such as hot brandy and water, ammonia and ether, given freely. If there is actual fainting, or difficulty in swallowing, a tube should be passed down the œsophagus, and if that does not let off the air, the stomach-pump might be applied.

(2) The ordinary cases of swelled abdomen from secreted air are perhaps better without any special treatment, as the inconvenience is of sufficiently little consequence to be a useful test of the progress of the recovery. This is not the place to speak of the general treatment dependent on the general symptoms. Where the inconvenience is really much complained of, or where, from diseased heart or lung, the pressure upwards of the diaphragm by the air in the alimentary canal is to be particularly deprecated, an enema of aloes and tincture of myrrh, or the rue injection of the pharmacopœia, will be usually successful: if not, a drachm of sulphuric ether may be added, or assafœtida.

(3) Fœtid flatus, that is, flatus of which the smell is not that of healthy fæces, but of decomposed organic matter, indicates that the duty of the physician lies in restoring some decided deficiency in the process of digestion. Most commonly it is the liver and small intestines which are wanting in activity, so that the stools are scanty, slimy, and irregular. The most effectual remedy is mercury, in small doses, combined with light, vegetable tonics, such, for instance, as a nightly powder of hydrargyrum cum cretâ, and a dose of decoction of sarsaparilla, or infusion of gentian or of red bark, thrice a-day. The quantity of unabsorbable woody fibre which is contained in these vegetable medicines appears to be of an advantage, as it carries the active portion of the drug lower down the alimentary canal, and perhaps also is useful in forming a more bulky fæculent mass. The dietary should be sparing, and all difficultly soluble albuminous articles should be avoided: such for instance as solid white of egg or meat pastry. Warning also should be especially given against food in a state of half decomposition, such as game long kept, stale fish, ripe cheese, medlars, sour beer, half-fermented champagne, &c. These not only decompose themselves, but cause all that surrounds them to decompose too, turning wholesome victuals into noxious poison.

More might be added concerning the collateral treatment of cases in which flatulence is the main inconvenience, and that first complained of by the patient: but to proceed through all these would make the chapter rather a treatise on disorders of digestion generally, than one on the special symptom under consideration. There is usually no difficulty in referring instances of flatulence to some of the other pathological conditions already described.

CHAPTER X.

REGIMEN.

THE intention of the present chapter is to discuss a few of the most important questions of dietetic and alterative medicine in relation to invalids, which may occur to the reader in looking over the corresponding chapter in the former part of this work.

SECTION I.—*Spare Diet as a Remedy.*

The diminution of the quantity of ingested nutriment in acute illness is so instinctively taught us by nature, that nobody probably was ever bold enough to sustain an opinion contrary to such an obvious law. The quantity and quality of the food ordinarily taken by the healthy body invariably requires modification during even the slightest derangement.

The natural explanation of this is, that the power of absorbing nutriment from the alimentary canal is more or less arrested, and that therefore the ordinary amount of victuals is an excess, and constitutes a foreign noxious body. It is not improbable, too, that in some cases the power of continuous renewal of the tissues, or the fixing of the liquid nutriment in the solids of the body, is arrested to a still greater degree even than the power of absorption, and hence that an excess may be absorbed and remain in the circulation, as some of the semi-vitalized substances which are familiar in morbid fluids. For the first case, a simple diminution of the quantity taken at once would suffice; for the second, a modification of quality is necessary.

These truths, acted on by a prevalent spirit of ascetism derived from false views of moral nature, have led to two very common fallacies—first, that an *over-nutritious* diet is a cause of disease; secondly, that the same diminution of nutriment which assists in the *cure* of disease would *prevent* it, if persisted in during health.

The rich man's table is injurious to him, not because it groans with plenty, but when that plenty appears in the shape of greasy, over-cooked, concentrated dishes, flavoured with essential oils and alcohol in condiments and stimulants—when the aliments are half putrified or half fermented to gratify a desire for novelty—when, in fact, a quantity of drugs and foreign noxious substances are taken with the food, so as to impede the absorption of proper nutriment, and arrest healthy metamorphosis. Such a diet, instead of being too nutritious, deprives the most essential part of the frame—the muscular—of its proper supply. The only tissue which it can contribute to augment is the adipose, and even that is most usually unable to derive its natural supply from the altered oleaginous matter. The results of such mismanagement of the body are, not the *increased* metamorphois which would be the consequence of increased supply, but the manifestation of *arrested* metamorphosis in gout, rheumatism, biliousness, deficiency of gastric juice, painful digestion, weakness, anæmia, neuralgia, hysteria, &c.

The principle of cure common to these disorders is, to enable the alimentary canal to digest and absorb as much normal nutriment as it possibly can, without impeding its action by a load of foreign matter.

When this argument is clearly set forth, it is obvious enough to medical men, and does not require to be insisted upon. But it does require to be explained to patients, who, led away by some semi-moral popular writers, suppose that disorders which they are conscious are brought on by eating too much, can be best treated by eating too little. Hence they often aggravate their state by protracted fasts, by innutritious food, and abstinence not only from unwholesome, but from wholesome diet also.

It very often excites the astonishment of these patients, after having it explained to them that their complaint arises from over-eating, to be told to increase the number of their meals. Yet such is in most instances the best way of meeting the case. Small quantities frequently taken are the best device for introducing into the system a full supply of nutriment without overloading the alimentary canal. During the day, four hours is the longest time that an invalid should be allowed to pass without eating something; and for some two hours is a sufficient interval. Very soon the appetite begins to accommodate itself to these habits, and the little meal that is committed to the stomach at once, instead of lying dormant in the paralysed organ for hours, as was the case under former customs, is enabled to pass away rapidly. Natural hunger gives warning of this improved state of things.

Prejudiced patients are apt to complain that under this plan they never "enjoy" a full meal; that their dinner, luncheon, or tea, or the like, is "spoiled" by a nameless repast taken so shortly before. So much the better; the enjoyment (so-called) of eating as much *at once* as other people, is the very thing that keeps up their complaint. Their comfort should be, that they are enabled, in the prescribed mode, to *digest* as much or more than even their healthy friends.

Small, frequent meals and light digestible diet should, then, be looked upon as the complete antithesis of spare diet, and the distinction should be pointed out to the patients put upon it. At the same time it should be explained, that though their complaints arise from *eating* too much, they do not arise from *digesting* too much, but often the contrary; and therefore thus are to be cured, not by offering the alimentary canal too little, but by offering it in such a form as can be taken up.

But there are classes of complaints, before alluded to, where the cure is doubtless hastened, or perhaps can be effected *only* by a temporary diminution of the quantity of nutritious matter submitted to absorption. Whether albumen and fibrin become actually converted into the semi-vitalized products found in inflammation, rheumatism, gout, and perhaps some other disorders, or whether their presence causes the increased conversion of tissues into the semi-organizable fibrin of inflamed blood, lithic acid, &c., is not known; but it is certain that the symptoms connected with the presence of those morbid matters yield sooner when the food contains the minimum quantity of the said nutriments consistent with life. Inflammations, acute rheumatisms, and acute gout, get well quickest in those patients who can best bear starving. So very often, too, especially in acute rheumatism, do relapses follow closely on the increase of albuminized matters in the dietary, that it is impossible not to be struck with the advantage previously secured by the abstinence from these articles.

But it cannot be too often explained, both to patients and practitioners, that the low diet which is a means of cure, is by no means the most proper mode of preventing a *recurrence* of the disorder which has been removed by it. Those are most likely to avoid disease whose bodies are in the strongest condition of health ; and those are most likely to attain the strongest condition of health who absorb and fix in their bodies the greatest amount possible of the normal constituents of the tissues. The reduction of the diet to the smallest quantity consistent with life renders the body more liable to derangement; and when that derangement does come, it is then all the more difficult to apply the remedy of spare diet which, in better nourished constitutions, is so effectual. Gouty, rheumatic, inflammatory persons, and in fact all those subject to complaints for which an important remedy is the diminution of the amount of absorbed nutriment, should in their healthy intervals prepare themselves by wholesome sufficient food for the application, when necessary, of a rigid regimen: remembering that they are by this course at once arming themselves against the disorder, and preparing a place for its remedy in case it does come.

Another advantage of a generous diet is, that it allows of a high degree of destructive metamorphosis without consequent danger to the body. By its means, during health, water in full quantity, neutral salts, &c., and during illness, or for the relief of chronic complaints, mercury, antimony, purgatives, and other increasers of destruction, are enabled to be taken under circumstances which would be rendered impracticable by spare diet. The full supply of nutriment fills up with healthier constituents the blanks which we desire to occasion by the removal of the abnormal or degenerated tissue.

It is by this means, and by this means alone—by well-chosen diet, in conjunction with well-chosen medicines—that we can ever hope to combat that tendency to degeneration in the interstitial frame-work of the body which the microscope is daily revealing to us as the cause of almost all chronic complaints,* and which has been conjectured, with a fair show of probability, to be becoming more and more ingrained in the human race. To hasten the moulting of the effete abnormal substance, and to supply that which the invigorated powers can convert into active, healthy substance, is the only rational mode of meeting this state of things, which morbid anatomy teaches us is so common.

The above is the physiological explanation of the success which has often attended upon the empirical practice of hydropathy. Administered in accordance with the sober dictates of reason, and without that exclusive prejudice in its favour which cannot but be engendered by the present arrangements of its promoters, there is no question but that it might be made an useful handmaid to Rational Medicine. But to ensure the remedy a fair trial, several reforms are necessary. In the first place, a careful selection of proper cases must be made, and those failures not reckoned which are due to the obstinacy of the patient in choosing a remedy not suitable for the disorder, or those successes which are referable simply to leaving off some deleterious treatment or practice. Then the conjunction of other remedies and modes of cure, in aid or compensation of its action, must be recommended; and, above all, the ill-fated alliance of innkeeping and the art of healing must be broken off before hydropathy and science can profess open friendship.

Varied modes of administration have already, even among its most headstrong advocates, taken the place of the uniform excessive treatment of its first introducer to modern notice. This is a great step in advance, and when not empirical, but more based on physiology, these graduated doses of the remedy are entirely in accordance with the principles of rational medicine.

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* See pp. 308 et seq.

SECTION II.—*The Action of Neutral Salts on the System.*

The comparative simplicity of the conditions of the animal body required for the appropriation of substances freely soluble in water, enable them to be absorbed and to produce physiological effects under circumstances considerably removed from the normal. There is no state probably in which water and neutral salts are not more or less diffusible through living membranes, and thus capable of introduction into the system. They are therefore widely applicable, as remedies as well as food, in all states of disease. I do not mean to say that they are always beneficial, but that they can always be administered.

But at the same time it must be remembered, that the solubility and power of diffusion which favours their introduction, favours also their rapid removal; so that in direct proportion to their diffusibility is the necessity for quick repetitions of the dose.

The application of this principle in the administration of the class of remedies spoken of is obvious. We must give them frequently and continuously, in proportion to their solubility, whenever we wish the manifestation of remote effects, as distinguished from their immediate physiological action.

This reasoning also leads us to dilute fully those salts whose effects we wish to be exhibited in modifying nutrition, such as natural mineral waters, &c. Concentrated solutions, even of the least active of them—as nitrate of potash, for instance—act as purgatives, when the addition of a little more water would have caused them to be absorbed; so that two quite distinct effects are produced by the same drug, differently administered.

The most recent experiments on the physiological action on the digestive canal of solutions of salts, are those of Professor Buckheim*. They were performed with the view of testing the truth of the conjecture, that the purgative action of these solutions is a consequence of their slight diffusion-power, which prevents their being absorbed by the mucous canal, and causes them to flow through the bowels as a foreign stream, washing with it all that lies in the way, outstripping in its course the sluggish peristaltic motion. Sulphate of soda and chloride of sodium were the substances selected for experiment, and they were tried partly upon two young men in ordinary health, and partly upon dogs.

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* *Archiv für Phys. Heilkunde*, 1ster Heft. 1854.

The results of these experiments may be shortly stated as follows:—

1. The taking of sulphate of soda caused always an increase in the sulphuric acid naturally contained in the urine.

2. This increase was greater the less the evacuation produced by the salt, and the longer the stools could be repressed.

3. Repression of the purgative action, by opiates or tannic acid, produced the same result as repression by voluntary effort,—viz., a derivation of the salt to the urine, instead of the fæces.

4. The result was unaffected by the quantity of water taken with the salt.

So far the experiments were made upon our own species, the next were upon dogs.

5. Sulphate of soda, injected into the blood, produces no increased peristaltic action or purgative effect. Indeed, the fæces were drier than without it.

6. The rapidity of the passage of salts into the urine is probably proportioned to their diffusion-power. To try this, chloride of sodium and sulphate of soda were taken, mixed together. The excretion by the urine of the former reached its maximum in three, of the latter in nine hours. The fæces contained an excess (indeed nearly the whole) of the Glauber's salt, while of the kitchen salt there was no excess in them.

7. Opiates do not impede the absorption of salts and the diarrhœa which they prevent comes on later, unless it is so long repressed that all the salt can be taken up.

Hence we may conclude, that probably the cause of the action of purgative salts is their comparative deficiency of diffusion-power; that they remain as a foreign liquid body in the intestines till either they are allowed to be passed by stool, or are slowly absorbed; and that when absorbed into the blood their physiological actions are of quite a different character.

The foregoing experiments and deductions point out most clearly the importance of dilution in assisting the absorption of neutral salts, and they should be kept in mind when we are prescribing such remedies for the sick.

It is probably the dilute state in which they are presented to the intestinal canal, that renders natural mineral waters so advantageous to the chronic invalid. No active physiological action, such as might prevent their continuance, results; and they are, therefore, able to be persisted in till a gradual interstitial change in the solids of the body is produced—a change which, in properly selected cases, is synonymous with health.

The simplicity of the requisite conditions for the absorption of this class of medicines, gives a peculiar facility to the mode of administering them by their application to the external surface of the body. By this means the remedy is perhaps more directly introduced into the general circulation, than when taken up from the intestinal canal, and at the same time its specific effects on those parts are avoided. For instance, sulphuretted hydrogen, or raw sulphur, cannot be administered by the mouth in sufficient quantities to affect much the general nutrition of the tissues; it acts on the mucous membrane and muscular coat of the intestines, and that oftentimes in a degree by no means desired by the physician. Whereas, in baths the consequences are quite different, and are much more readily beneficial. The same may be said of the salts in sea water and mineral springs, of iodine, bromine, &c.

Baths are too commonly looked upon as merely diversified combinations of heat, cold, and moisture, and lotions as merely stimulating or evaporating, as the case may be, forgetting the influence over interstitial changes exerted by their absorbable ingredients. I think great advantage may be taken of this influence. In rheumatic fever, for instance, I have several times fomented one part with plain water, and another with a solution of carbonate of soda, and have found the greater relief given by the latter very strikingly exhibited: so much so that I have not any longer felt justified in repeating the test of the treatment, by omitting the alkali in any locality. The use of lead lotions I cannot restrict to the mere chemical effect of astringing the skin and driving the blood from the capillaries it contains. I believe the metal to be deeply absorbed, and for this reason to exhibit its well-known power of restraining inflammatory action. A proof of this penetration is afforded by the carbonate or white lead, which, sparingly soluble as it is in the fluids of the animal body,* may yet be taken up through the skin in such quantities, and penetrate so deep, as to produce paralysis of the neighbouring muscles. I have seen boys employed at the white lead works to carry buckets filled with the preparation, become palsied in that hand and fore-arm which was employed in the work, and not in the other unemployed arm, and not at any time affected with colic or other general symptoms of lead poison. They exhibited the *local* only, and none of the *constitutional* effects, showing that the poisoning was local only. I have seen, also, cases of lead poisoning in plumbers, who have been employed only in rolling sheet lead, and have not touched, or been exposed to inhale the more dangerous carbonate in any way; and analogous bad results are stated to have followed the employment of lead powders to dust children's skins with.

The absorption through the skin of the insoluble carbonate, or still more intractable metal, takes away all pretence for incredulity about the entrance by the same path of salts and other soluble substances. It inclines me to look with favour on the disputed good effects of bathing in mineral waters, and not to attribute them solely to warmth and moisture, as some are disposed to do.

It appears from some experiments recently made by Dr. Homolle,† that the effect on the body of the application of neutral salts to the external skin, is not simply the addition to the blood and other fluids of the salt absorbed, but that we have yet to learn many mysteries of the absorbing process before we can use medicated baths according to the laws of rational medicine. Dr. Homolle finds that while the urine is rendered only neutral by plain water baths, it becomes alkaline when the bath contains either alkaline, neutral, or even acid salts; and that when chlorides, iodides, or ferrocyanides are thus applied to the external surface, the chlorine, iodine, or cyanogen does not reappear in the urine. He finds too, that organic substances do not pass as such into the urine through the cuticle, but that the renal secretion is made alkaline by baths which contain them.

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* When speaking of the solution and absorption of lead and many other substances, we must remember that the fluids of the animal body are not pure water, but impregnated, almost to saturation, with salts and carbonic acid, in which metallic bases are often more soluble than in water. This is especially the case with the carbonate and phosphate of lime, which the fixed air in the aqueous circulation probably alone enables it to take up.

† *L' Union Médicale.* Paris. October 5th, 1853.

If the experimenter is correct in his observations, neutral salts are decomposed in their transit through the skin, the base alone passing through the system, and probably alone exerting its specific powers.

The therapeutical indications to be drawn from these experiments appear of considerable importance, as we are led thereby to class together medicinal baths by their bases, neglecting their acid constituents, except so far as they impede or assist the solubility of the base, or exert any topical external action on the skin. We are led, also, to see that we can apply an alkali externally quite as efficaciously in respect of its interstitial action on the tissue in the state of neutral salt, as pure or in a state of carbonate—a consideration of no slight importance when the local action of alkalies on the cutaneous surface is considered. We are enabled to give an alkaline bath without running the risk of irritating and saponifying a delicate skin, simply by the employment of a neutral salt instead.

The practical inferences capable of being drawn from the foregoing observations on neutral salts, are,—

(1) That they may be given with the expectation of specific results in all diseases.

(2) That they should be given in small and repeated doses, in proportion to their solubility.

(3) Opiates do not prevent the absorption of neutral salts, but turn them from purgatives into diuretics. The addition, therefore, of opiates to medicines intended to act on the kidneys is rational and experimentally useful.

(4) Neutral salts should be much diluted with water, to be administered with best effect.

(5) Medicated baths are an efficient addition to internal remedies.

(6) When absorbed by the skin, the important part of the neutral salt is its base; so that we may give a patient, whom we wish to impregnate with an alkaline carbonate of soda or potass, the same base in a neutral salt with equal effect and much greater convenience to himself.

(7) Baths of vegetables or other organic substances, do not indeed produce the same result as when the substances are taken by the mouth, but still are not quite inert, as they act as alkalies. They are proved by experience more useful than plain water in cases of gout and rheumatism, if not in other disorders.

SECTION III.—*Oleaginous Remedies.*

Though oily medicines are strictly a complementary food, it is not the wisest plan to mix them with other food, or to take them near the time of meals. By adopting such a mode of administration (as some physicians have recommended), one of the chief advantages of the remedy is lost—I mean the advantage of *securing to the absorbents the nutriment over and above that which they are used to.*

The dose of oil should, in fact, constitute an *extra meal*, and when it does so the system is in a fair way to derive the greatest benefit therefrom. When taken with, or close upon dinner and breakfast, it is of little more use than the same amount of fat bacon or beef, and often indisposes the patient to eat the proper amount of nutritious food, which is in fact replaced instead of being reinforced by the oil prescribed.

Another advantage of fixing a period remote from meals is, that the physician is then better able to detect when his remedy really disagrees with the digestion. It is unnecessary to say that there are a great number of cases where this happens, and where its possible benefits to the system at large are forestalled by the injury accruing to the stomach or bowels. It is easier to discern this when the complication of food digesting at the same time is avoided.

The *form* in which fat or oil is presented to the alimentary canal is rendered important principally by its tendency to spontaneous decomposition. Exposed to heat and to other substances in a state of fermentation, it readily becomes rancid, and in that condition cannot be taken up, or at least not with the same ease as when fresh. Habitually weakly persons soon learn by experience to avoid all those forms of oleaginous matters in cookery by which this tendency to decomposition is fostered. Greasy pastry, butter sauces, rich made dishes, are abstained from by them without medical commands. But the application of this familiar principle to the administration of medicine is often overlooked, and physicians are found recommending strong, rancid cod-liver oil, for example, in preference to the fresh and sweet. Not only does this often disagree in cases where it is highly desirable that oil should be taken, but it gives the patient such a disgust to the class of remedy altogether, that it cannot be swallowed without nausea, even when pure. The clearer and less nauseous oil is, the better for the consumer at all times.

The tendency of animal oils to become rancid, from heat and fermenting acids, is much checked by the addition of a fixed alkali, such as liquor potassæ or carbonate of soda, to the usual draught. The sickly taste, which they cannot but have, even at their best, is most pleasantly covered by orange-peel tea, and by chewing a piece of dried orange-peel before and after the dose. These two simple measures will often enable cod-liver oil to be taken by those with whom it has disagreed in every other way.

When we speak of oleaginous medicines, we naturally think of fish oil. Experience appears to show that it is better suited than any other for quick absorption into the tissues. Other animal fats are either too nauseous, too expensive, or have too much resemblance to ordinary food exactly to suit the required purpose, and have never received the full trial which this preparation has. It is very doubtful whether the small quantity of the elements of the bile, of iodine, or other extraneous matters in it, have much to do with the advantage which follows cod-liver oil: and the great amount of benefit which has been traced to it is probably due to its enormous consumption, and the consequently large scale on which the experiment has been tried.

Vegetable oils are certainly not so readily taken up by the villi of the intestines. If you give a dose of oleum ricini to a person taking regularly cod-liver oil, you will often find that though the animal medicine has been so entirely absorbed in large quantities that it never reappears in the fæces, yet the single dose of vegetable oil passes directly through the bowels, and is found floating in an opaque mass in the close-stool. Hence we might fairly anticipate what seems to be the result of experience with respect to olive oil, that it is not so beneficial as its more commonly used relative.

The most eligible substitute for fish oil, is cream. Where it can be got fresh, it seems to do as much good as the nauseous oil. It may be taken in the form of new warm milk, with a teaspoonful of rum in it, where the stomach is strong enough to bear the casein; where that disagrees, a tablespoonful of cream in a glass of soda-water is a good substitute, and is one of the pleasantest remedies possible.

Alcohol is often a valuable addition to oleaginous or other fattening medicines. An instance of the assistance afforded by it to the process of forming adipose tissue, is exhibited in the use of refuse grains for fattening animals. But a more striking one was brought forward at the Thirsk Agricultural Meeting in 1850, by Mr. Outhwaite. That gentleman fed a pig on a pure diet of rum and new milk, and caused it to increase in ten days from 37 stone 10 lbs., to 42 stone 12 lbs., thus adding to its body 72 lbs. of fat. It is worthy of remark, that a mixture of alcohol with the food was much more effectual than the administration of it alone; for Mr. Outhwaite's pig, when fed on milk and ale in separate troughs, did not fatten nearly so quick. It was probably on this principle that Dr. Bardsley, of Manchester, used many years ago to give his patients cod-liver oil in warm beer; and I have several times seen the benefit of the oleaginous treatment much enhanced by the addition of wine to the dietary.

SECTION IV.—*The use of Alcohols by Invalids and others.*

The employment of alcoholic drinks is indicated in diseases—

1. Where the pathological condition limits the due supply of nutriment, and the repair cannot therefore equal the normal destruction.

2. Where the destruction is so excessive that normal repair cannot equal it.

Under the first head come all acute typhous conditions, and in fact all acute diseases, not excepting inflammatory ones, where the "nervous" energy (as it is vaguely called, meaning vitality in general) is defective. The use of wine in pneumonia in surgical injuries, and in general the not being frightened out of stimulation by the anatomical termination in "*itis*," has saved many a life of late years in this metropolis; and although perhaps it may not so often be required in the more bracing air of regions to our north-east, still even there the practice is gaining ground against prepossession, showing that it is really beneficial.

But a case more nearly related to the subjects of the present volume is that chronic one where the alimentary canal is habitually unequal to its duties,—that of the "poor creatures" alluded to at page 300. It is certain that the habitual daily use of a small allowance of alcoholic drinks bestows on this large class the nervous energy necessary to digest enough food to exist upon, and to get through other vital functions. By this stimulus they are enabled to be useful members of society, instead of the mere drones they must become during the rest of their existence under a "total abstinence" regimen.

Whether the inefficiency of the body for vital functions arises from imperfect lungs, imperfect stomach, or any other of the blood-making viscera, the use of alcohol makes it more vigorous, more able to support the fatigue of existence (for to the invalid mere existence *is* a fatigue) and to perform the ordinary duties of life.

There are two objections to the habitual use of alcohol, often urged by total abstainers, which require discussion. One is, that the effect of it is only *temporary*, and therefore that when it has gone off the consumer is at least in no better, and most say, in a worse condition than he was before. The second is, that *use must lead to abuse*, that moderation is the first step to excess, and that the original effect can, after a time, be produced only by a continually increased dose.

To the first I must concede, that the *immediate* effect is indeed only temporary. But that is no just accusation against its utility. The *secondary* effect may be, and *is* in proper cases the enabling the body to assimilate food which, without its aid, would have been unassimilated, to take exercise and perform normal duties which would otherwise have been unperformed. The immediate effects of meat, of water, indeed of every influence to which the individual is subjected, are temporary, but still no one objects that to them.

It may be freely granted that both the primary and secondary effects of food have a value infinitely greater than that of alcohol, and that alcohol cannot take the place of food. But in cases where only a limited quantity of the latter can be taken, it is good economy to limit the metamorphosis which demands more than can be given to it. And how numerous these cases are, how probably in many large classes of our brethren they may constitute a majority, is too well known to the reflecting physician.

The second position—viz., that moderate indulgence leads eventually to excess, has to support it the practical fact that exceeders certainly do generally begin by moderate indulgence; indeed, it is difficult to conceive their acquiring the habit in any other way. But to ground an argument for abstinence on this is to fall into the errors of ascetics, who would proscribe female society as leading to unlawful love, never change their dress lest vanity should be gratified, and avoid speaking in order not to sin with their tongues.

The special and somewhat insidious argument by which alcohol is exhibited as that pleasure the use of which peculiarly tends to abuse, is the statement, that in *order to produce the original effect, the dose of it requires to be gradually increased.* It is stated that so much depression of vital energy follows the excitement arising from the stimulus, that what was at first sufficient is powerless, and an augmented quantity is demanded, which again produces an augmented depression and demand for a further increase.

Now there would be a good deal in this argument if the depression and the arrest of metamorphosis, which are the consequences of alcohol, were permanent or everlasting—if something was taken away which could never be restored; it would be valid also if the habitual temperate indulger wished to keep up a continuous excitement. Such however is not the case; the system has time to recover itself before the instinctive accessory is again resorted to, and is agreeably benefited by exactly the same quantity as before; for no one who calls himself temperate would think of taking alcohol with a following meal till the effect of that taken at the previous one had gone off. As a matter of familiar fact, men take their pint of beer or wine daily with their dinner for years, feeling daily the same beneficial exhiliration from it; and when on festive occasions they increase their allowance, the same result always accompanies the excess.

The fallacy of the supporters of "total abstinence" (to use the technical term) lies in this: they assume, or allow to be assumed, that the individual man consists always of the same identical particles of matter, and that an impression made by a temporary influence is everlasting. But such is not the truth. Constant change—perpetual metamorphosis—is that in which life consists; and the same atoms acted upon by a stimulus to-day, do not remain to be acted upon to-morrow. The body therefore does not become used to an habitual stimulus, if the whole circle of effects of that stimulus are at each renewal allowed to be gone through—and for this reason, that it is not in fact the same body as it was before; daily food has prepared a new tissue for the daily work; and the renewal of the stimulus, supposing organic injury not to be done, finds new matter in the old form to be acted on in the old way.

These statements of the fallacies in the physiological basis of teetotalism, are to the majority of my readers perhaps merely proving a point which they never denied. Yet I cannot think them entirely useless, even then. For we must all confess a certain kind of attraction for arguments, however specious, which claim to be aspirations after the moral amelioration of our race; and we are by education and religion inclined to look with suspicion on any habit which is pleasant. Add to this that the zealous and conscientious supporters of abstinence theories have engaged accomplished physiologists and eloquent lecturers to plead the arguments in favour of their cause, and lay considerable stress on the physical facts and metaphorical illustrations which, at first glance, and without examination of the other side, might tell for them. To fortify ourselves against these fallacies, into which the best part of our nature might lead, it is not without value to reiterate the fact, that *use is not* *abuse*, and that there is an essential difference, not in *degree* only, but in *nature*, between temperate enjoyment and excess.

The best line of distinction between the two—the best test for the practical man, whether he is taking in alcohol a food or a pleasant poison—is to be found in its effects during those hours between meals during which digestion is going on. If the body during this period is more active, more efficient for the mind's purposes when alcohol is taken than when it is not, we may feel sure that the individual, whether healthy or invalid, is benefited by it. If, on the other hand, the senses are blunter, or the muscular system is weaker, or the guiding powers less steady within four hours after the meal, the probability is, that in all but exceptional cases the alcohol is either not beneficial at all, or is taken in excess. This reference to the moral relations, to the final purpose of the corporeal frame, is similar to that which was made in the distinction between health and disease in a former chapter,* and is certainly more generally applicable than any merely physical test. The same rule is applicable to the normal and abnormal state, and though here spoken of invalids, holds equally good for the robust.

A question may naturally occur to a cautious man, willing to know the real merits and demerits of accessory foods in his case, whether, allowing immediate good results, an accumulation of postponed evil may be expected to come on in the end? He may say that truly he feels himself stronger and grow heavier for a week or a month, but does not some indefinite disease or shortening of life repay him at last with interest?

This is a very common fear with "the million:" a book lately had a considerable sale, writ by an unfortunate man, who traced all the evils to which flesh is subject to the use of salt: to tea has been ascribed all the imaginary degeneracy of the nineteenth century: tobacco, again, has been so "counterblasted" by royal and other pens, that one might imagine smoking had only to be stopped to free the world of half its miseries. In the case of alcohol, a more insidious *ad hominem* argument is used, and the fears of the individual for his own safety are more pointedly appealed to by the teetotallers; so that we constantly find well-educated people, while half ashamed of their irrational bugbear, and not influenced in practice, yet made miserable and deprived of rest by it.

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* Page 223.

The best answer is the statement which all physiological and medical experience will not fail to prove—viz., that *where the digestive powers of the alimentary canal are made stronger, where the muscular system becomes more powerful, at the same time as the whole body increases in weight, no future harm will result.*

In a volume like the present, there is of course no place to discuss the *moral and political* aspects of total abstinence. A physican's duty is to set forth what is best for the individual body, as is done above, and to dissuade temperate persons from entering into engagements which may shorten their lives and impair their usefulness. Still more is it his duty not to allow fallacious theories to interfere with the health of the individual patients who have entrusted their bodies to his care. But let it be remembered, that not a word has been said here against any person or association united for the purpose of avoiding and discouraging *excess.* They have undertaken a noble and a holy work, but all history, revealed or recorded, shows that it is one which ascetism will only retard. It would also be folly to deny the wisdom of many persons imposing private vows of abstinence on themselves, for the sake of health or prudence. But it may be surely questioned whether they have a right to persuade others to undertake the same to their detriment.

SECTION V.—*Obesity as a consequence of Imperfect Digestion.*

Obesity is in some cases accompanied by large appetite, while in others the food taken or wished for is not greater, occasionally even less, than natural.

When the appetite is large it will often be found that the digestion of animal food is imperfect, that semi-dissolved muscular fibre is passed by the fæces, and consequently that the requirements of the system demand more than it can get out of a moderate diet, and an excessive one is instinctively adopted. At the same time the assimilation of adipose matter being easier than of albuminous, more fat is added to the body than is consistent with convenience. For there is no meat which does not contain fat.

Under these circumstances, our aim must be to detect the imperfection in the digestive organs, and to remove it. By this means, generally, power is gained to take more exercise, and while the assimilation of albumen adds strength to the muscles, increased perspiration and respiration diminish the store of adipose tissue. As a rule, then, it may be said that the cure of obesity is easiest when it is accompanied by indigestion and a large appetite.

When the appetite is small, and yet the patient continues to increase in unhealthy weight, the case is a more difficult one: there is usually great congenital or acquired weakness of muscle, the circulation is often irregular and inefficient from the heart being thin, feeble, or laden with fat; and hence it is next to impossible to get the proper amount of exercise taken. It will be necessary to bring into play all the more troublesome and powerful items of the special treatment, and very great patience and strength of mind will be required for success, both in patient and physician.

Since obesity is so often due to disorders of the digestive organs, and since its treatment consists almost entirely in the management of those organs, it may not be out of place to bestow upon it a few pages here; although it has already been made the subject of a special treatise by the author, discussed in greater detail, and joined to the general physiology and pathology related to it.*

The first thing indicated is to cut off, as far as possible, the supply of material for adipose tissue. Fat, oil, butter, should be rigorously interdicted from the dietary. But all eatables contain some portion of oleaginous matter, and especially those most convenient to advise the use of for a lengthened period. And probably many more destitute of fat† are capable of an adipose fermentation when a small quantity of this substance is previously present. It is desirable, therefore, that the mass of food should lie in the stomach as short a time as possible, in order that at least a fatty fermentation may not be set up in it. Very light meals should be taken at times most favourable to rapid digestion, and should consist of substances easy of solution and assimilation. To this end the time of the meals should be fixed for an early hour in the day, before exertion has rendered the powers of the alimentary canal languid. Breakfast should consist of dry toast, or still better of sea biscuit, and if much active exercise is intended, a piece of lean meat. Dinner at one, on meat with the fat cut off, stale bread or biscuit, and some plain boiled macaroni or biscuit pudding by way of second course. We must be careful to explain to our patients what strangely enough they are often ignorant of, that any light dishes we recommend are not beneficial of themselves, but by excluding others more hurtful. I have heard of a dyspeptic gentleman who, having been informed that a particular sort of biscuit was suitable for him, declared he would never dine without them, but as he usually ate largely before their appearance, the expected advantage did not follow.

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* With the title of *Corpulence, or Excess of Fat in the Human Body*; being the substance of the Gulstonian Lectures for 1850. Published by Longman, but now out of print.

† With respect to the formation of fat from albuminous matter, see page 312. See also MM. Boussingault and Persoz, *Annales de Chimie*, xviii. p. 462, on the formation of it in the intestinal canal.

Liquids should be taken sparingly at all times, for I have known several cases of obesity where the habit of consuming largely aqueous drinks, such as tea and other "slops," was the main cause of the complaint, which diminished sensibly by the mere abstinence from them. Alcoholic drinks are still more injurious, when in excess, by arresting the metamorphosis of fat, which we should endeavour to compass by exercise. Here should end the feeding for the day; no second dinner or supper should follow, nor indeed any more meals be taken *sitting down*. A piece of biscuit and a glass of water will relieve faintness, and a little beef tea on going to bed prevent broken rest from hunger.

This is not a scale of diet by any means unattainable. A retired butcher and pugilist, whose case is mentioned in the volume alluded to above, adopted it by my advice with comfort to himself for several years, and is able upon it to work in a violent manner in a small garden which he cultivates for himself in the suburbs of London. He has reduced himself from twenty to seventeen stone; whereas his brother, who has not the same strength of mind, has increased to twenty-three stone in weight. Persons of refined education may, and often do, practice the same self-imposed control more easily. The case of a professional gentleman is quoted in the same place, who had reduced himself from twenty-two to eighteen stone, and sometimes brings the scale down to seventeen, but finds that he derives no particular advantage from being of the lower weight.

The smallest amount of nutriment consistent with the health of each individual, can only be found by experiment; but we need not fear that ten ounces of solid food a day is too little, for the last-mentioned gentleman confined himself for a long period to that quantity, and found his mental and bodily powers always equal to the strain which the pursuit of a laborious profession in London demands. It may be remarked that it is often advisable to add a small allowance of malt liquor to dinner among the upper classes, as otherwise the craving of the appetite is less easily appeased.

In cases where the fat is largely accumulated in the omentum, it is very convenient for the patient to wear a band round the abdomen, which may be tightened gradually. The support thus given to the abdominal muscles relieves the dragging sensation in the loins which many persons, whose viscera are heavy in proportion to their strength, experience. It enables exercise to be taken with more facility, and appears also, by pressure, to afford some assistance to the absorption of fat.

The above remarks will apply equally to all forms of obesity; the abstinence recommended can be borne even by the aged, and only comfort be experienced. As respects exercise, however, a distinction requires to be made. The young and vigorous cannot employ themselves better than in devoting the greatest number of hours possible to hard bodily exertion. But in elderly people, and some asthenic cases, this is not practicable. The deficiency of muscular power prevents the use of the limbs long enough to be advantageous. But where riding can be managed, it should on no account be omitted, and the suspensory belt before mentioned is often a valuable auxiliary to the employment of this exercise.

The ancients were more in the habit than we are of using various forms of friction to the skin in chronic complaints of the internal viscera; and there is in Aurelian a recommendation to the corpulent to employ rubbing, either alone or with the addition of dry powders.* Modern habits of cleanliness supersede in some degree these remedies. But the skin of the obese is not unfrequently greasy from a thick sebaceous secretion, and the circulation through it languid in asthenic cases, and here considerable advantage is derived from the stimulation. The pleasantest way of applying it is powdered orris root, rubbed in with Sir John Rolt's horse-hair gloves every morning till the whole skin is pink and glowing. A shower bath afterwards completes the arrangement.

The vapour or hot-air bath is a still more efficacious remedy. The quantity of sebacious secretion which can be brought out by this means is sometimes enormous, and can be compared only to the *vernix caseosa* of the new-born infant, while the diminution of weight I have seen to go on at the rate of a pound a day.

Aurelian sensibly advises these remedial measures to be adopted fasting, and no food to be taken immediately afterwards. Modern habits render the period of first rising a convenient time.

To these rules of management, medicines, strictly so called, must be viewed as secondary, but yet they are by no means valueless. Purgatives I have found generally not needed in the plethoric form; the bowels usually act once or twice a day. But in the asthenic obesity of old people, where the abdominal walls are weakened by the long-continued pressure of abnormal weight it is necessary to employ them. The best guide is the state of the bowels; if they are natural, I would avoid purgatives, as I do not think that such treatment reduces corpulence *per se.*

Diuretics, iodine, vinegar, I have never found of any advantage, and the ingestion of useless drugs must be injurious to the digestion.

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* *Aurelianus, Morb. Chron.*, l. v. cap. 11.

In speaking of remedies which do harm, it may be mentioned that loss of blood is always very badly borne by obese dyspeptics, whatever may be the matter with them. The reason probably is, that the vast extra extent of capillaries which their large size entails, not being accompanied by any augmented strength in the heart, the latter viscus is comparatively, though not absolutely, weak, and the circulation unequal to the additional duty imposed upon it.*

But there is one class of medicines so universally applicable to all cases of obesity, that I think a trial of them should never be omitted. The chemical affinities of alkalies for fat point them out as appropriate alteratives in this complaint, and experience shows that they are suitable to the state of the digestive organs. The most eligible one is liq. potassæ, as it may be administered in much larger quantities than any other. If given in milk and water, we may safely commence with half a drachm, and raise the dose to a drachm or a drachm and a half three times a day.† The milk covers the taste of the potash better than any other vehicle. It has truly the disadvantage of saponifying a portion of the remedy, but there is no proof that its efficacy is thereby endangered; indeed soap itself has been found empirically useful: a physician, whose case is recorded by Dr. Flemyng, reduced himself, by Alicant soap alone, two stone in weight.‡

Several striking examples of the advantage of this remedy are cited in the more special work; it has not however been the plan of this volume to detail cases, but rather to allude to the familiar experience of all; or to base new propositions on the analogy of physiology.

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* See p. 349.

† I have often given the above named doses of liquor potassæ (even to children, in cases of scrofula) without injury, when taken in milk. The fear of alkalies has probably arisen from the injury observed by Huxham (*On Fevers*, p. 48) to follow the use of Mrs. Stevens's "stone medicines," at one time so popular, and therefore often misapplied. The injury arose probably from their being used in debilitated cases, phosphatic urine, and the like.

‡ *Discourse on Corpulency.*

SECTION VI.—*The General Hygiene of Chronically Deranged Digestion.*

There are several points of common treatment which should be carried out in *all* derangements of the digestive canal when in a chronic state, and which therefore have not been mentioned under any one head, that repetition might be avoided. They differ very little from what is advisable in the derangements of the mucous membrane in other parts.

A warm dry air, and exercise sufficient to keep up the circulation and temperature of the skin, are of as much consequence here as where the bronchi and the mucous system are chiefly affected. Flannel next the body keeps the capillaries of the cuticle open, and at the same time prevents the sudden chills which are so injurious in this state. Cold extremities during sleep should especially be avoided, and hence the putting the feet into hot water at night is a beneficial practice. But it must be remembered that "coddling," or the unmanly avoidance of changes of temperature, is by no means a proper mode of sustaining the warmth of the body. Indeed, fresh air, and sudden and frequent exposure to a certain degree of cold, seem necessary to keep up the due circulation of the blood and the vital metamorphoses which generate animal heat. For all classes of dyspeptics there are few things more pernicious than the monotomy of temperature which is the aim (fortunately unattainable) of many theoretical ventilators and warmers.

Bathing I believe to be beneficial chiefly (though, as before remarked, not *entirely*) by reason of the change of temperature which it entails. The open river, the open sea, with the fresh winds of heaven to dry you, and the sun to warm you, are the best. The air bath is of as much consequence as the water. Hence, as bathing places there are no localities equal to the indented creeks of Devonshire, where a "machine," with its well known frowsty atmosphere, is not required for decency or comfort, as is the case in our open downs.

All, however, have not the vigour of circulation required to bear the exposure, and in such cases an approach to the Turkish and Russian system is advantageous—I mean a sudden change of temperature in the water used. A hot bath of 99° or 100° may be got into, and before leaving it a stream of cold water thrown over the body. By this means a glow and reaction is induced which neither a hot bath nor a cold bath separately could have given birth to. A fair substitute for this is to stand with the feet in hot water in a sponge pan, and have a jug of cold poured down the shoulders. The beneficial result of even ordinary sponging, such as many persons adopt merely for cleanliness, is very marked. But open sea bathing is the culminating point of hygiene, and the patient who arrives at that may view his gastric symptoms as practically at an end, or at all events in his own power.

I cannot say that I have seen so much good result from the application of the cold douche to the epigastrium as from ordinary bathing. Such a mode of proceeding was in high repute among the ancient Romans, who, from their disgusting *cuisine*, were very subject to indigestion of all kinds; but it is to be observed, that their best writers place it second to swimming,[*] and my experience is similar. In fact, it is not the local effect on the ailing organ, so much as the general improvement of the circulation and nutritive functions which depend thereon, that is to be desired.

Travelling is a very useful means of effecting a complete change of diet. It is equally valuable as an instrument of hygiene. Not only the change of from a bad to a good air is useful, but the constant *variety* of atmosphere and other conditions which travelling alone can supply, have an independent advantage. Even the scampering tours so much patronized by our countrymen, are better than none; but infinitely more beneficial is a leisurely change from place to place, affording variety without bustle, and exercise without toil. This is the true luxury of travelling, even for the healthy, and for the invalid is a still higher appreciated arrangement.

The choice of place must depend as much on the special *cause* of derangements of digestion as on its form. Should they arise principally from an overstrained mind, from too close attention to business, domestic cares, literary labour and the like, a tour may be chosen which presents the greatest possible change of scene, and constantly fresh pictures of life and manners;—the picturesque quaintnesses of Flanders, the Moselle, or the Meuse, the architectural grandeurs of Normandy or Picardy, or the mediæval savageness of Brittany, offer short trips of a month or six weeks of complete change. If we are sure our patient's mind is at ease, the bracing air of the east and south-east coasts of England succeeds better; but a heavy care-laden soul must not be sent to eat into itself in the dulness of those English watering places. Where the diet is of so much importance as it is in cases where the intestines are peculiarly affected, it has been before remarked (page 372), that the British mountains afford a more eligible temporary home. The south-west coast of England, with its moist air and equable temperature, is peculiarly injurious to most dyspeptics, and as such, except there is joined also some disorder of the chest to the derangement of the abdominal viscera, is never to be recommended. There are, however, several places in the neighbourhood of this coast which lie high, and so have a more variable and bracing air, to which dyspeptics who reside in that part of the country may resort with advantage—such, for example, as Clifton near Bristol, the neighbourhood of Dartmour, &c. These examples may serve to indicate the principle on which a selection should be made, and to suggest a place more convenient perhaps than any of those here named.

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[*] See *Celsus*, l. iv. c. v., and *Aurelianus, Morb. Chron.*, l. iii. c. ii,

The attractions of sporting may be added in its various degrees, according to the taste of the individual, from adventurous fox-hunting, down to the mildest of all mild modes of destroying life—float-fishing. Entomology and botany have cured many a sedentary citizen of indigestion.

It is superfluous to multiply suggestions of this kind. The selection of a pursuit which will encourage change of air, place, and scene, must be finally left to the tastes of the patient and the discretion of the medical adviser.

A few cautions require to be given about exercise. Good it doubtless is for everybody, but *not at all times.* Those who suffer from the slow digestion arising from gastric flux, must be careful to avoid exertion too soon after a meal. They should also not sit down to eat with their body wearied out.[*] Both practices aggravate their symptoms, and are eventually also injurious. These cautions should without fail be impressed upon those whom we have induced to travel for the relief of gastric derangement; for if they do not adopt them, there is a risk of our advice being followed by as much harm as good.

Some persons rebel against the law against active exertion after eating, because they say it condemns them to so much sluggish idleness. And they have reason on their side. Gentle employment of both mind and body should be engaged in. The Latin physicians, who really seem to have understood the management of the digestion better than the majority of their successors, showed excellent good sense on this point. They recommended to the dyspeptic, after meals, reading out loud, then a stroll, and then the more severe movements of the upper extremities in golf, tennis, fencing, or the like.[†] Now reading has been too much overlooked of late as a bodily exercise, and the benefit has been doubted, because of the awkward manner in which it is done. Look at a Greek or Roman representation of a man speaking or reading—he is standing up, or sitting back with the chest thrown well forward and dilated, the nostrils open, and the shoulders flatter and more erect than when walking. The artist's model evidently has the lungs filled with air, and the diaphragm at rest, so that full play is given to the elastic cartilages of the ribs. The man is rolling out his words really *claré*, as Celsus has it, comfortably to himself, and agreeably to his hearers. Observe, as a contrast, many a modern reader or orator—his constrained attitude recals rather the architectural angularities of Gothic art; expressing perhaps the earnestness and self-denial which that style may be held to indicate, but certainly not wholesome ease. The head is bent forward, a stiff neckcloth compresses the windpipe, the lungs are emptied, and the words are squeezed out by an effort of the diaphragm and abdominal muscles which makes the listener fancy he can almost hear them creak with the strain. They are used at an enormous mechanical disadvantage, and the nervous energy of the whole trunk foolishly exhausted. Hence, reading and preaching, instead of being a relief to gastric derangement, are now-a-days often found actually to produce it; the clergyman's sore-throat and dyspepsia have often been traced to their professional work; and that which might have been a cure has become an aggravation. There was, some years ago, a quack in the Isle of Wight, who used to treat clergymen very successfully, under a promise of secrecy. His method was simply to teach them to keep the chest inflated by breathing in only through the nose, and to allow it to empty itself by the elasticity of the cartilages as the patient spoke. This plan entails the habit of straightening the windpipe, sitting or standing upright, and throwing the should-back, in fact, of assuming the attitude which I have described as a model for the reader, and is for that reason found practically beneficial.

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[*] See pp. 97, 304.

[†] *Celsus*, l. i. c. viii.

If patients can sing, they possess a part of the materia medica very valuable to their digestion. They will seldom require the hints above given, for most leading masters have found the necessity for teaching their pupils a rational attitude, and the ordinary time for exercising their art is the hour after the meal that most requires attention. It is striking how rarely powerful singers suffer from gastric derangement.

SECTION VII.—*The use of Insoluble Matters in the Food.*

Insoluble matters—such as the cellular tissue of vegetables and fruits, the husks of grain, the bones and skin of animals to a certain extent—are sometimes spoken of as if they were entirely useless to the animal economy, and therefore could only injure the alimentary canal by being taken into it. They are spoken of as likely to "irritate" the bowels, and are therefore excluded from the dietary of invalids.

I do not think these ideas are in accordance with either physiological or practical observation, and appear grounded solely on theory.

In fact, the foreign matters really found to irritate the bowels or cause diarrhœa are *not* insoluble; it is the decaying and fermenting sugar, gluten, and starch of plants which give rise to the disorder, and not the cellulose, which is passed by the bowels in an unaltered state; while unoxidizable masses, such as gold and silver coins, stones, knife-handles, &c., are never hurried in their transit through the alimentary canal, and never do any but purely mechanical injury.*

One great use of insoluble substances is to give a bulk and consistence to the fæces, which when they consist of the mere *débris* of the tissues, they often fail to possess, especially in persons not in perfect health. The contracting muscles of the alimentary canal, particularly those of the colon, have something resisting to press upon, and are thus better able to exert their full strength, and to empty the canal they surround. It is for this reason that the bran in brown bread is so often beneficial to those liable to constipation, and not because it "irritates" the bowels into healthy action, which is a result that never happens. Green vegetables, such as spinach and cabbage, will often, from their large proportion of cellulose, have the same advantage over potatoes for persons with debilitated large intestines.

Another use is the mechanical separation and dilution of the food; so that instead of being presented to the absorbents as a solid mass, over the external surface of which alone they can exert influence, it may be offered in small quantities at a time. It is obvious too that the digestive juices can penetrate such a mass more gradually and effectually than where the whole consists of digestible materials.

It is possible also that some insoluble carbonaceous matters may be of use, by soaking up the superfluous water from the bowels and absorbing noxious gases.

Now all these duties require performance more in invalids than they do in the healthy, and I therefore think it a false principle which would exclude insoluble matters from their dietary. The contrary plan will practically be found to succeed best, and, as shown above, is really justifiable on physiological grounds.

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* In cases where coins are swallowed for felonious purposes, the officers of justice know well that it is false haste to give purgatives. Those experienced in such transactions let matters quite alone, and in good time the foreign substances are steadily carried downwards by the solid fæces, which when liquid fail to move them.

Besides the main design of drawing attention to the important function which is the special subject of this volume, the author has had in view the exhibition of an example of that mode of treating pathology and practice which may justly be called Rational Medicine—that is, the deduction of our rules for the management of disease from the scientific observation of health. In this lies the chief hope of continuing the recent advance of our art. The suggestions of physiology must indeed be confirmed and corrected by experience, and the mind must be kept liberally open to the teachings of that daily mistress; but the positions of the two must not be reversed; nor must either be put out of sight, as is done by those who would base treatment on empirical discovery alone. One is a bridle and the other is a spur, and to use one without the other is as dangerous as mere routine or a universal panacea; but united and in their proper places, they conduct, I believe to correct principles, and I know to successful practice.

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